# POWER

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# Boiler Makers Become Steam-Plant Builders

A BOILER PLANT used to consist of one or more boilers, a reciprocating steam pump or injectors, usually both in case of trouble with either, and an open or closed feed-water heater operated with exhaust steam. In larger plants economizers were sometimes used.

The boilers were usually of the shell type and every district had its boiler shop, available for and expert in repairs as well as in new work.

Separate companies made the different apparatus. There were numerous pump companies, some of which made pumps that would supply anything from a six-horsepower boiler to a municipal waterworks. Others made the feed-water heaters, the injectors, grates, economizers, etc. The coal was handled in barrows and hand-fired, usually on stationary grates.

The modern boiler plant has become much more exigent and complicated. The shell boiler, although simple, inexpensive and efficient, has its limitations in respect to pressure and capacity. Its building is more of an art than its making used to be and the artizan works with the strain gage instead of the drift pin. The handling of the larger and heavier plate required for the greater sizes and pressures now in use exceeds the ability of many of the older small shops and many of them have passed out or gone largely into other lines of work.

The modern steam-generating plant of large capacity and high efficiency bears little resemblance to the old boiler house. The boiler itself, completely changed in form and type, is combined with superheaters, air preheaters, economizers and water walls. It is fired by mechanical stokers, pulverized coal or oil. Air for the previously impossible rates of heat generation is supplied by huge fans instead of by chimney draft, and a single unit does the work of whole rows of boilers of the shell type.

The building of such installations requires such facilities and equipment, such engineering and financial resources, such adaptation of the various components to one another that the development of organizations equipped to furnish them more or less completely is natural. The movement manifested by recent combinations may be expected to progress in the direction of the absorption of individual manufacturers of the separate apparatus and the more complete coverage of the installation by fewer large concerns.

J. R. Low

# EDITORIALS

## A Short-Sighted Policy

SOME MONTHS AGO the engineering department of a certain industrial decided that it should replace an old pump with one of special design. Negotiations were carried on with the pump manufacturer and the order was about to be placed when the appropriation was unexpectedly held up by the company executives on the ground that it had been decided to get along with all present equipment until business had picked up.

Failure of the old equipment, a few months later, made the purchase of the new pump imperative and a rush order was put through. This necessitated overtime, and the resulting cost was at least a third more than the price originally quoted.

This incident serves again to emphasize the short-sighted policy of interfering with normal replacements by blanket executive decree. Such decisions should be made only after giving due consideration to the recommendations of the engineering staff who are in better position to pass judgment on the needs of the power department. To make the order inflexible is courting trouble.

The depression has plenty of sins laid to its door, but it is good business to relieve it of this one. Normal maintenance and replacement is the breath of life to any going industry.

## Give an Ear to The Operating Man

SOMEONE has facetiously defined an expert as "an ordinary man away from home." This thought, if coupled with the biblical quotation that "a prophet is not without honor, save in his own country and in his own house," provides all the wisdom necessary to understand why it is that the thinking of some power house operators does not get any further than the weather side of their boss's offices.

Not all of the brains are surrounded by white collars, and besides, who has a better first-hand knowledge of the actual operation of the equipment, its shortcomings or the possibility for its practical improvement than the man whose duty it is to keep it going?

Granted, the operating man may, at times, find difficulty dressing up his ideas, but this can be no excuse for not listening and encouraging their expression. It is a matter of record that many of the best consulting engineers regularly make it a practice to talk to the operating men whenever opportunity affords. Thus, much of value is added to their store of consultant's knowledge and later respectfully received by the president or the general manager, for a consideration.

The value of suggestions from the men in some industries has been recognized in many places by the installation of "suggestion boxes" and employees are sometimes rewarded for accepted ideas.

But the extension of the plan to the power plant and power services in the factory is rare indeed. Then too, sometimes the very fact that the suggestions must be written, automatically estops some valuable idea that could be told, if there were only someone to listen and conscientiously endeavor to help in its formulation.

This procedure, of course, presupposes that the boss is willing to concede that his power house men may be experts or prophets for him as well as for the outsiders wise enough to seek their ideas.

## Modern Boiler Equipment Broadens Choice of Fuels

OBSOLETE EQUIPMENT in the small industrial boiler plant and the saving possible by replacing it with modern and efficient fuel-firing and furnace equipment continues to be the subject of considerable thought.

A phase of the matter that has not, perhaps, been given its proper weight is the further and larger savings when equipment is selected with a view to its adaptability to a wider range of fuel choice.

Every large industrial area offers a variety of fuels with considerable choice in physical and chemical characteristics. Nowhere is this truer than in the Central Eastern section, including Pennsylvania, New Jersey and New York, where coals ranging from anthracite steam sizes to low-grade bituminous are available. Heat values

vary from 11,000 to 14,000 B.t.u. per pound. Ash fusion temperatures are from 2,000 to 3,000 degrees, and volatile contents from 7 to 33 per cent.

Prices, however, while vaguely following the heat value, vary from 25 to 40 per cent for the same energy content. One might well question the possibility of selling a million B.t.u.'s packaged as bituminous coal, for, say, eighteen cents when on the same day and in the same general form an equal quantity of heat energy could be bought for twelve or fourteen cents.

The answer lies largely in the limitations of usability placed by the fuel-burning equipment on the form in which this energy may be utilized. Some of these limitations, of course, are inseparable from the practical aspects of fuel-burning, and not even the best-designed of furnaces will handle the entire range of Eastern coals. Too many small industrial boiler plants, however, continue to "make steam" with inadequate boilers having low settings or old hand-fired grates of restricted area and with draft equipment gasping as it strains to "push" the plant over the peak.

Steam costs in these plants are high—not only because of the coal wasted, but because the equipment restricts fuel choice to the narrow range of "special" coals selling at high prices, and these very prices are frequently created by the demand from other plants in the same predicament.

Any investigation seeking the justification of modernizing the boiler plant should include a study of the available fuel market, present and future. Frequently, such a study will indicate that a modest expenditure, judiciously applied, will put the plant in position to choose its fuel from a wider range where the fuels, being ample in supply and competing one with the other, sell on a more nearly comparable heat-value basis.

## Wanted—
## A Feed-Water Moses

THE "white man's burden" in power generation is mostly chemical. Remove from the problems of operation those related to combustion, to corrosion and scale, to priming and foaming, and the job would not be half as difficult as it is.

The field of feed-water treatment, in particular, is like that of medicine. There are a lot of sick people and a lot of doctors. Lots of cures are made and yet there is no agreement on the best medicine—not even the best medicine for a precisely defined set of conditions.

For a single given set of water conditions the equipment recommended to the power-plant operator may be a zeolite softener, or a hot-process softener or a deconcentrator or an evaporator or the feed of chemicals directly to the boiler, or various combinations of these. It is recognized that each of these has its field, but they cannot all be best for any one set of conditions.

Large utility and industrial plants may move with wisdom through this chaos of advice, guided by a skilled staff chemist, devoting a large proportion of his time to feed water problems. But how about the typical industrial plant? It has no chemist. The engineer learns much from experience, but cannot be expected to master feed-water chemistry along with a dozen other specialties. He must to some extent guess or lean on salesmen, or hire a consulting engineer, of whom not many are intimately familiar with feed-water problems.

Clearly the power engineer needs a Moses to lead him out of this wilderness, a man distinguished alike by his intimate knowledge of feed-water problems and by his complete freedom from commercial bias. There is a considerable amount of feed-water knowledge in existence, but it is confined almost entirely to the manufacturers of water-treating equipment and materials. There are, it is true, a few—very few—consulting engineers able to deal expertly with such problems. They are too few to meet the demand for competent, impartial opinion.

## Interstate
## Export of Power

ACCORDING to statistics recently released by the National Electric Light Association concerning the interstate export of central station power, Vermont heads the list with 67.4 per cent of that generated within its borders, Idaho is second with 59.5 per cent, while Maryland and the District of Columbia combined practically tie West Virginia for third place, the percentages being 45.6 and 45.4, respectively. Although the figures are not broken down into steam and hydro power, it is evident, from a knowledge of the power installations within these states, that, excepting West Virginia, the bulk of this exported power is hydro.

The average for all the states of the Union is 13.1 per cent of the total power generated, representing a total of nearly twelve billion kilowatt-hours. This reflects the activity in system interconnection that has been going on during the last few years and emphasizes the increased interest that is being shown in proposed interstate regulation of power.

▼

## POWER Stands for . .

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

▼

# Pulverized Cracking-Still Coke and Absorber Gas as Boiler Fuel

**This particularly dry and abrasive coke, for which there is little or no market, is being burned successfully in pulverized form in a boiler furnace in combination with waste gas from refinery absorbers**

IN THE Toledo refinery of the Standard Oil Company of Ohio there is a fairly uniform demand for steam to the amount of 3 to 4 million pounds per day of 24 hours. This steam is supplied at 130 lb. pressure for electric generation and pumping and as the process supply for cracking operations. Prime movers for the generating units and the pumps are non-condensing turbines which exhaust at 5 lb. back pressure into a common exhaust main incircling the works. There are uses for all of this exhaust steam during the heating season and for the larger part of it during the summer months.

Eleven years ago an attractive boiler house was built and has been so maintained, the management being strong in the belief that cleanliness and congenial surroundings are conducive to efficient operation. It was equipped with eight 5,000-sq.ft. water-tube boilers of the longitudinal-drum, straight-tube type, each provided with a forced-draft chain grate having 126 sq.ft. of active area. Four hundred feet from the boiler house is the generating plant, containing two 500-kw. non-condensing turbine-generators and some steam-driven air compressors, and one-quarter mile distant is the pumping plant, in which are two 10,000-g.p.m. turbine-driven service pumps and two 2,500-g.p.m. fire pumps with turbine drive. Aerial steam lines supported by structural-steel columns distribute the boiler steam.

In supplying the steam demand, daily routine calls for the operation of six boilers at approximately 185 per cent rating. This operating plan leaves two boilers in reserve, so that it is feasible to take one boiler off the line each month for cleaning and repairs to the setting. The fuel used at the plant is run-of-mine bituminous coal from Ohio.

Within the past four years the management has been endeavoring to minimize the coal requirements by utilizing the waste fuels available from the refinery. The first effort was to burn the gas from the absorbers, which ordinarily is wasted to atmosphere. Large quantities of this waste gas, containing about 900 B.t.u. per cubic foot, were available. It was first burned under the stills, and as the supply exceeded the demand the mains were extended to the boiler house.

From the common supply main two lines lead up to each boiler, entering the furnace at each side of the stoker and 2 ft. above the grate. The gas flow is directed toward the centerline of the unit, the two streams meeting near the middle of the furnace. Stoker operation is also maintained so that the two fuels are burned simultaneously. One boiler burns gas at all times, and the additional number required to use all of the gas is determined by the pressure in the main.

Another byproduct of which a considerable supply had accumulated is petroleum, or refinery, coke. Two grades are available. One grade, known as crude residuum, comes from processing in crude stills of the coking type; the other grade comes from cracking stills and is known as cracking-still coke. Having a higher volatile content, the crude residuum is a more desirable fuel, so that there had been demand for it up to the available supply, except, of course, the screenings from the car loadings. There is no market for the cracking-still coke. It is very dry and abrasive, low in volatile and has just a trace of ash, as may be seen from the accompanying typical analysis.

TYPICAL ANALYSIS OF CRACKING-STILL COKE

| | Per Cent |
|---|---|
| Fixed carbon | 89.20 |
| Volatile | 7.30 |
| Ash | 0.25 |
| Moisture | 3.25 |
| Sulphur | 0.60 |
| B.t.u. per pound | 15,213 |

To dispose of this coke it was necessary to find an economical method of burning it. Its heat value exceeded 15,000 B.t.u., so that 1 lb. of the coke would be equivalent to about 1¼ lb. of the coal in use. With practically no ash and an intense fire needed to maintain combustion, it was impossible to burn it alone on the stokers. Mix-

tures with coal up to 25 per cent coke were tried, but as the coke was relatively light, holes were blown in the fire, and the results obtained were unsatisfactory.

Experience of this character led to the decision to equip one of the boilers with a unit mill. The stoker was removed and a furnace of 3,700 cu.ft. volume was built up of Bigelow-Liptak suspended-type air-cooled walls, consisting of 9½ in. of suspended block, a 6-in. air space and a 4-in. outer brick casing. Side, front and rear walls and the furnace floor are air-cooled. The air is admitted through dampered inlets at the bottom, and passes upward through the vertical passages in the walls to be collected at the top and delivered to the mill at a temperature of 300 deg. Some secondary air is admitted around the burner, principally to keep it cool, and additional air near the bottom of the furnace, because in operation the presence of a vacuum in the lower front corner was indicated by the curling of the flame in that direction.

A Strong-Scott mill, equipped with a vortex burner, was installed. The nominal capacity is 4,000 lb. per hour, but 50 per cent additional capacity is possible. A 75-hp., 1,800-r.p.m. Terry turbine drive was selected to give flexibility in speed, as the electric generating capacity of the plant is limited, and use can be made of the exhaust steam.

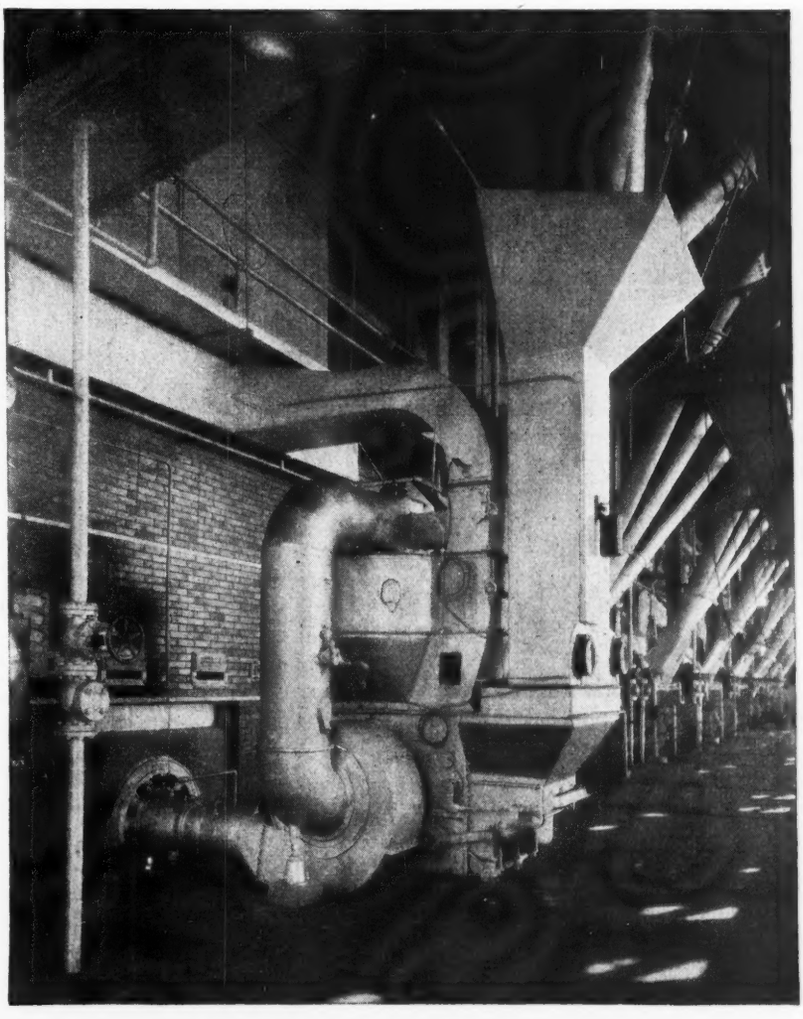
The coke produced at the stills comes out in lumps as large as 18 in. in the longest dimension. It is transferred in railway cars to the boiler house siding, to be passed through a crusher into an open storage pit. The crushed coke is picked up by an overhead electric crane which dumps it into the bunker serving the respective boilers. Feed to the mill is measured by a propeller-type meter located in the down spout from the bunker.

The original intent was to burn the coke without a secondary fuel and this was done with a certain degree of success. According to the fuel- and steam-flow meters, the evaporation per pound of coke ranged from 10 to 12 pounds.

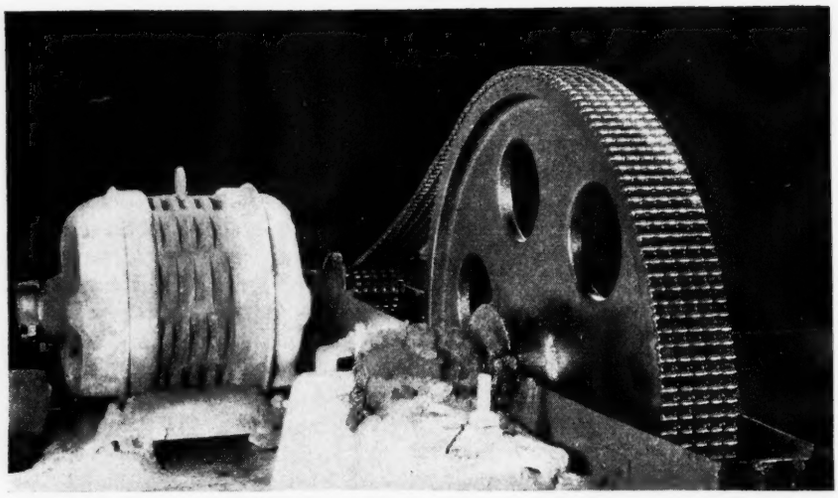
With the coke alone, however, it was difficult to maintain ignition, and it was found that if the $CO_2$ exceeded 13 per cent the furnace temperatures became so excessive that the walls would start slagging. As a consequence the furnace was equipped with two gas burners, one on either side, as before; and most satisfactory conditions now prevail. Ratings from 150 to 225 per cent are carried normally, and upon one occasion the load was run up to 320 per cent rating without difficulty. The gas supplies the volatile that is lacking in the coke, so that there is no difficulty in maintaining ignition, and the $CO_2$ is maintained at 15 per cent without causing undue furnace temperatures. About 35 tons of coke are burned per day, and as this is equivalent to 44 tons of coal costing $3 per ton delivered the daily saving in fuel is $132.

The new furnace also is well adapted to burn gas alone. After the furnace has been warmed up the two burners will carry 75 per cent of nominal rating. Before starting up the pulverizer it is the practice to operate on gas for three days to thoroughly saturate the furnace.

In the simultaneous burning of the two fuels combustion conditions are entirely satisfactory. The only difficulty reported is excessive maintenance on the rotor blades of the mill, owing to the highly abrasive character of the coke and to the cinders and dirt that come along with the screenings from car loadings. With coal the probable life of a set of blades has been given as 1,500 to 2,000 tons. With the abrasive fuel used in the present installation the blades wore out while handling 850 tons. In the new set of blades a coating ⅛ in. thick of No. 9 high manganese steel was fluxed onto the wearing faces of the blades by means of the electric arc. It is the hope that this expedient will bring the blade life back to normal or close to that obtaining with coal.



**Unit pulverizer arranged to burn cracking-still coke**



Complete inclosure protects this quintuple ¾-in. pitch roller chain from grit while transmitting 20 hp. from a 1,160-r.p.m. motor

# Power Transmission by Roller Chains

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ROLLER-CHAIN and sprocket design has been so improved that their applications include the entire range of shaft speeds up to 4,000 r.p.m. In this article, which is the first of three, principles of design and operation are given; a second will deal with roller-chain applications; and a third with their lubrication and maintenance

ROLLER-CHAIN drives are used so widely that many are familiar with the reliability that characterizes this medium for power transmission. However, the scope of applications for which roller chains may properly be employed is not so generally realized. These chains are no longer limited to slow- or moderate-speed applications. Improvements in design, in steels, in metallurgical practices and in manufacturing processes have extended their fields of usage to the same extent as is true of other types of power-transmission equipment. Modern roller-chain drives are no more like those of the nineteenth century than do modern gears resemble their predecessors of that period.

Roller-chain drives are used for the entire range of shaft speeds, including recent automotive camshaft and auxiliary drives of 3,000 to 4,000 r.p.m. High shaft speeds require light, short-pitch chains, this principle paralleling the practice of employing short-pitch gears or light belts for similar work. Heavier chains are suitable for slower speeds, and because their dimensions are more substantial, their power-transmission capacities are greater. When conditions are favorable, ⅜-in. pitch chains may be used for transmitting as much as 20 hp. at 3,600 r.p.m.; 500 hp. may be handled by 2½-in.-pitch chains; but the speed of the faster-running sprocket of the pair must not greatly exceed 240 revolutions per minute.

A roller-chain drive is essentially simple in construction. It comprises two or more toothed wheels, called sprockets, mounted on parallel shafts and engaged by the links of an endless roller chain. The distance from center to center of two adjacent chain joints is the chain pitch and sprockets pitch. The pitch diameter of a sprocket is the diameter of a circle drawn through the center of chain joints in mesh with the sprockets.

A roller chain is a series of oscillatory, uniformly spaced bearings, consisting of roller links connected by pin links. A roller link or inside link is an assembly of two rollers on two bushings, Fig. 1, the ends of which are pressed into holes in two inside links. A pin link or outside link is an assembly of two pins, the ends of which are pressed into two pin-link plates. A connecting link is a pin link having one sideplate readily detachable.

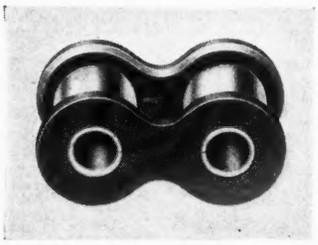
An offset link, frequently called a half-link because it is a roller link at one end and a pin link at the other, consists of two offset-link plates, a bushing, a roller and an offset-link pin. When an odd number of pitches is needed in an endless length of chain one offset link is used.

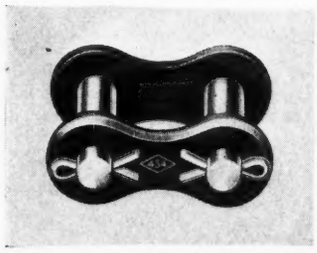
Medium-carbon cold-rolled or medium-carbon hot-rolled alloy steels, heat-treated, are most frequently used for sideplates. Low-carbon and alloy steels suitable for

case-hardening are most used for pins, rollers and bushings. Grinding provides for well-finished surfaces to resist wear and for accuracy and uniform dimensions. The most important attribute of roller chains is wear resistance between pins and bushings, a property dependent, other things being equal, on the hardness and finish of these parts. Good design, proper proportion of parts, is necessary to obtain balanced strength throughout the chain, accompanied by light weight. None of these can be sacrificed without proportional loss of mechanical value.

To provide power-transmission capacities greater than those of single strands, that is, greater bearing areas within the chains, roller chains are compounded, Fig. 4. Standard roller chains are built up in multiple widths consisting of series of parallel roller links and sideplates, assembled on pins.

Double, triple and quadruple chains are carried in stock by the chain makers, and for special applications even greater multiplication of strands has been developed. In





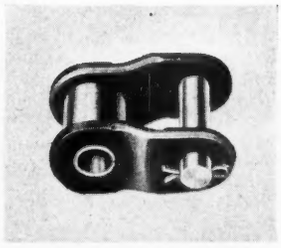


**Fig. 1 (Left)—Roller-type link. Fig. 2 (Lower left)—Pin-type link. Fig. 3 (Below)—Offset link**

comparison with single-strand chains, power-transmission capacities are substantially in proportion to the number of strands, and paired multiple-chain drives are feasible and practicable. More power can be transmitted with multiple-strand chains, at a given speed, than single-strand chain is capable of handling at the same speed. It is also possible to transmit a given amount of power at shaft speeds four times as great as could be recommended for single-strand chains.

Tensile strength of good roller chain must be more than adequate to resist, without permanent deformation, the maximum loads which can be imposed even by peak conditions. Extreme strength obtained at the cost of excess weight is a valueless liability. Tensile strength is significant only in preventing chain breakage, and it is noteworthy that replacement of chains in normal service is required only on account of wear, that is, pitch elongation to where it prevents proper meshing with the sprocket teeth.

For many years all manufacturers of roller chain produced sizes identical in those dimensions—pitch, roller diameter and chain width—which provided interchangeability over the same sprockets. Intercoupling of pin links and roller links of some sizes of the various makes was a matter of chance rather than intention.

The convenience of users dictating that intercoupling be universal, regardless of the make, representatives of the major roller-chain makers, the American Society of Mechanical Engineers, the Society of Automotive Engineers and the American Gear Manufacturers Association developed and recommended, over a period of years, not only pitches, roller diameters and chain widths of a standard series, but also pin diameters, inside plate thicknesses and ultimate limits of all those dimensions which provide for interchangeability of complete assemblies of parts among the various makes. These recommendations, together with concommitant recommendations on sprockets and sprocket cutters, were sponsored by those organizations and were approved as American standards by the American Standards Association.

Like all other mediums for the mechanical transmission of power, roller chains begin to wear as soon as they are placed in service. The rate is minute, but continuing as it does as long as the chain is in use, there must be provision in the form of the sprocket tooth for compensation for this continual lengthening of the chain pitch.

The oldest form of sprocket tooth was cut with clearance on the pitch line. This prevented interference by the rollers of an elongated chain with the backs of the teeth, but resulted in carrying of the entire load by one tooth at a time, the transference of load from tooth to tooth being accompanied by a slight jerk.

In the American standard tooth form, pitch-line clearance is eliminated. The contour of the tooth faces is such that the rollers tend to climb the teeth as chain-pitch elongation progresses, automatically adjusting themselves to conform with the chain pitch and load. This distributes the latter among a number of teeth and pro-

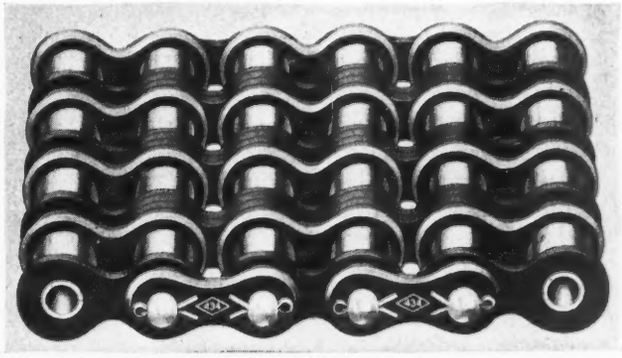


**Fig. 4—Standard quadruple roller chain, cotter type, 1-in. pitch, rollers ⅝-in. diameter by ⅝ in. wide; suitable for shaft speed up to 900 r.p.m.**

vides for its smooth and quiet transference to other teeth as they engage with the chain.

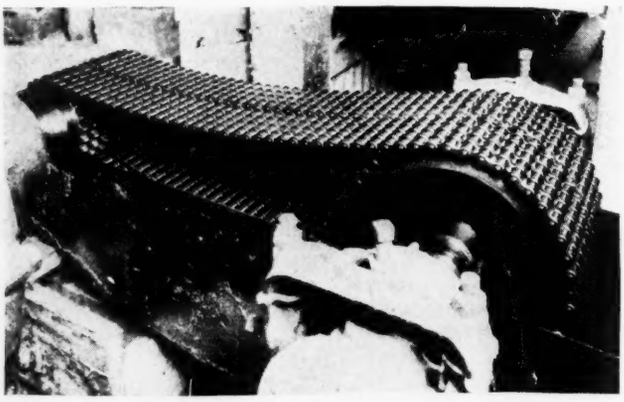
Sprocket accuracy is vital to roller-chain performance. Tooth shape must be correct, chordal pitch exact, and bottom diameters held to close limits. If the latter are too large the sprocket pitch will be too great and accurate chain will not completely wrap the wheel. If bottom diameters are too small the meshing of accurate chain will be similar to that of partly worn chain. For sprockets with odd numbers of teeth bottom diameters cannot be measured directly, but the measurement across two spaces most nearly opposite each other, usually called the caliper diameter, must be held to the same limits as bottom diameters. Outside diameters are relatively unimportant; quite wide limits are not objectionable.

Concentricity of bottom diameters about the center of rotation is essential to smooth and satisfactory performance. For high rotative speeds, the variation should not exceed 0.004 in. total indicator reading, but for slower

speeds and for chains of relatively long pitch, greater tolerances are acceptable.

The chamfer on the sides of sprocket teeth should be generous and smooth. The thickness of teeth should be less than the chain width to facilitate meshing and avoid any possibility of a wedging action. Tooth faces must be parallel with bores, and bores must be accurate to insure true-running wheels free from weave.

Tooth strength is a factor of much less importance for roller-chain sprockets than for gears. Loads are shared among several teeth and are applied above the pitch line only when chains are badly worn. For normal service, tooth loads are applied below the pitch line near the bases of the teeth, which are inherently strong. The length of tooth bases, circumferentially, is just slightly shorter than the chain pitch. Radius of the tooth fillets, that of the seating curves or spaces between the teeth,



**This pump-lubricated roller-chain drive, with the top half of the casing removed, transmits power from a 125-hp., 880-r.p.m. motor**

is just a little greater than the radius of the chain rollers, which for standard chains is $\frac{5}{16}$ of the chain pitch.

In selecting materials for sprockets, wear resistance and not tooth strength should be the basis of choice. For wheels of cast materials, for which minimum cross-sectional areas and weight may be desirable in some cases, cast steel may be preferred to cast iron, especially if spoke sections and hub diameters are limited. Cast iron is ordinarily suitable for both low and moderate shaft speeds.

For small sprockets, in the neighborhood of 6 in., low-carbon machine steel is frequently employed, and at less cost than cast iron. Drop-forged steel is used occasionally. Either forged steel or cast steel are most used for driving sprockets of heavy chains.

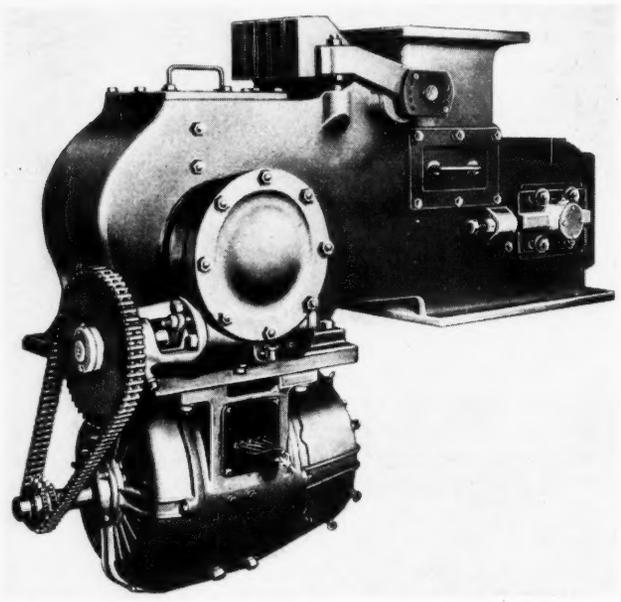
When ratios of drives are large it is advisable to compensate for the greater frequency of tooth contact of the smaller sprocket by providing greater unit durability of teeth than for the slower-running wheel. This is accomplished by using cast iron or unhardened steel for the latter and low-carbon steel, case-hardened, or a higher-carbon steel, heat-treated, for the pinion. The use of alloy-steel and case-hardened sprockets for diameters much greater than 9 or 10 in. is unusual and is rarely economical.

Analysis of the mechanics of the meshing of roller chains and sprockets will contribute toward a better understanding of their potentialities. As a rule, this subject is disposed of with the superficial comment that the action of the chain and sprockets is analogous to that of a non-slipping belt wrapping equilateral, regular, polygonal pulleys, a fact self-evidently true, without any exception, of all types of chain drives now in use.

A better comparison can be made by regarding the chain as a flexible rack, meshing with gears of an identical chordal pitch. All of the sprockets of an interchangeable set, that is all wheels which will mesh with chain of a given pitch and roller diameter, must have the same chordal pitch, but the circular pitches of sprockets having different numbers of teeth are not alike. All gears of an interchangeable set are of the same circular pitch, but not of the same chordal pitch. In this regard there is no similarity to gear action in chain-and-sprocket action, except in the positive, non-slipping meshing of both types of drives, and the circular pitch and chordal pitch become more nearly equal as the number of teeth is increased.

The primary function of the rollers of a roller chain is to minimize sprocket wear. When chains and sprockets are new, the rollers bottom in the spaces between the teeth and there is no rolling contact with the tooth faces. After the rollers are seated, and until they disengage, they are, for all practical purposes, integral parts of the sprocket rims, forming case-hardened linings between the teeth. While chain rollers are seated they have no motion relative to the sprocket teeth.

When chains are worn only one roller at a time bottoms between the teeth of each sprocket. The effective



**Coal feeder driven by a light double roller chain from 3-hp., 650- to 1,950-r.p.m. motor**

pitch diameters are greater than the original dimensions in proportion to the degree of chain elongation. Rollers of a worn chain engage the teeth a little above the original bottom diameter, an amount in proportion to the degree of elongation of chain pitch. As the sprocket turns, they roll in on the tooth faces, bottoming one at a time approximately halfway around the arc of chain engagement. They then roll out and up, the tooth faces having resumed disengagement at about the same position as on first meshing.

The outstanding consideration in regard to the meshing of roller chains and sprockets is the entire absence at all times, either with new or worn chain, of any rubbing or sliding contact between the tooth faces and the chain. This, together with its substantial construction, is responsible in a large measure for the high performance standard established by modern roller-chain drives.

# CORROSION PREVENTION

## By Protective Coatings

**Corrosion in power plants is of two major kinds, namely, atmospheric and under water. The surfaces subject to the former are by far the greater in extent. Under-water corrosion, affecting about 10 per cent of the iron and steel used in such plants, is probably more vital and is a factor in the safety of life and property. Corrosion can be retarded, if not prevented, by applying a protective film to the exposed surfaces**

By W. S. JOHNSTON
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THE PREVENTION of the corrosion of ferrous metals by means internal to the metal was discussed in a previous article.[1] The same objective may be attained by external methods. However, the treatment to be used can be determined only after knowing the causes responsible for corrosion. There are so many factors bearing on the subject that it is extremely difficult to establish a procedure that is applicable at once in all cases. As present considerations are confined to iron and steel, and especially to underwater corrosion obtaining in power plant equipment, the presentation of the various protective means that may be used for the purpose is simplified.

A protective coating may be natural or artificial, but, if impermeable, will retard general corrosion and tend to prevent the action of those factors causing localized pitting. Natural films are largely the accumulation of the products of corrosion, which, while affording some mechanical protection, actually accelerate attack as their porous texture absorbs moisture with dissolved oxygen. If materials in the solution form precipitates they, too, act as a protection to the metal. A common example is boiler scale. Where it is not impervious and is irregular in thickness, it may cause pitting. Generally it is necessary to depend on artificial films.

The exterior surfaces of the steel work and of the iron and steel parts of the equipment subject to atmospheric conditions are protected by painting. This method is successful if the surfaces are properly prepared to receive the priming coat. Loose mill scale, dirt, grease, etc., must be thoroughly removed by acid or electrolytic pickling, sand or chilled shot blasting, scraping or wire brushing and the primer applied to the dry bare metal. Pure linseed oil is the best vehicle for the primer. It should carry an inert pigment, such as red lead or sublimated white or blue lead. Iron and zinc oxides and lead and zinc chromates are used also as inhibitive pigments, either alone or in combination with one another. Excessive amounts of driers in protective paints should not be used as they shorten the useful life of the paints.

Metallic protective coatings have been used to minimize corrosion of iron and steel. The metals usually used are zinc, lead, tin, copper, nickel and chromium, as well as the magnetic oxide of iron, $Fe_3O_4$. Zinc is probably the most common metal in commercial use for this purpose because it is the nearest to being the ideal metallic protective coating. It may be applied by one of three methods. The electrolytic process uses a zinc anode and the zinc is deposited on the desired iron object as the cathode in a solution of zinc salts. Zinc is applied also by a hot process of galvanizing in which molten zinc cools upon the acid pickled surface of the article dipped in the zinc bath. The film is practically pure zinc. The method is expensive and has been cheapened by the sherardizing process. In the latter, zinc dust is heated and volatilized. The resulting film is an alloy of zinc and iron (90 and 10 per cent respectively), which resists corrosion better than pure zinc.

Coatings of tin and lead, or a combination of both, are applied by a hot process. Terne plate is the most common commercial product featuring these metals, but the coating is not lasting under severe conditions. Copper, nickel and chromium coatings are electro-depositions.

The Parker rust-proofing process, developed from those of Castlett and Richards, produces a film of iron phosphates which, being somewhat less of a cathode with respect to iron than oxide coatings, affords greater protection. The process uses a bath of iron phosphate, the iron on the surface of the article being treated goes into solution and its place is taken by insoluble phosphates of iron. The hydrogen deposited on the surface is removed by manganese dioxide and thus the process is accelerated. Generally upon removal from the bath and drying, a finish coat of paint or lacquer is applied to the article.

The Schoop process applies any of the protective metals mentioned above in the molten state by spraying them through a blow torch. The atomized metal is deposited while molten in a very thin coating that adheres tenaciously to the object sprayed.

Aluminum, while slightly anodic to iron, soon forms a protective film. It is applied by the calorizing process to the surfaces of iron and steel after the manner of the sherardizing process, but aluminum and aluminum oxide are used instead of zinc. Inasmuch as the process takes place at a temperature slightly over 1,700 deg. F., the working temperature of calorized metal cannot exceed 1,700 deg. F. However, calorized boiler soot blower elements and superheater tubes have been successfully used for nearly twenty years.

The processes based upon the use of metals other than iron employ those that are not easily and quickly corroded or are non-corrodible. They are expected to bear

[1] See *Power*, July 28.

the brunt of a corrosive attack, being better able to withstand it and thus protect the metal they coat. Metallic protective coatings are generally desirable because of their durability, adhesion to the base to be protected, uniform density, ease of application and low cost in some cases.

Magnetic oxide of iron, as an inhibitive, is formed by the Bower-Barff process. It consists of heating the object in a retort and oxidizing the surface with superheated steam. Complete oxidation is assured by then admitting carbon monoxide to convert any $Fe_2O_3$ to $Fe_3O_4$, which is practically noncorrodible. This process, however, slightly increases the size of the article treated and the strength of the metal is reduced somewhat. The Gesner process is similar to the Bower-Barff, but neither increases the size of nor distorts the article. The loss of strength and reduction in elongation is slight and the process may be used on large articles. This method has been improved upon by the Hydraesfer process in which hydrogen forms an alloy coating of hydrogen, copper and iron, giving an added surface resistance to corrosion.

The numerous processes just described have found limited application in power plant work, because of the expense involved. However, zinc coatings are used almost universally in the United States for the structural members of outdoor substations and for transmission line towers and their hardware. Practically all electrical conduits and their fittings are similarly protected.

Underwater corrosion takes place in power plants under two widely different conditions of temperature, that is, at ordinary temperatures and those considerably above. It occurs on the exterior surface of equipment partially or totally submerged in water and within equipment containing or conveying water and steam. Because rust formed by submergence is soft and porous it may be washed away by the velocity of the water. New surfaces are exposed to corrosion and thus velocity is a factor in the rate of corrosion under water.

### Causes of Underwater Corrosion

Dissolved oxygen is the principal cause of underwater corrosion, though other gases may be either contributing or controlling factors. Gaseous oxygen is more soluble than most of the gases that may be picked up from the air. Its total solubility is greater in cold water than hot, and greater in pure water than in a solution of other substances. For a given temperature, it increases directly as the pressure increases.

Circulating-water intake gates, valves, trash racks and stationary and traveling screens illustrate corrosion under water at normal temperatures. The submerged parts are usually protected with bituminous paints, made by a combination of asphalt or coal-tar pitch and mineral oil spirits or oleo-resinous varnish. However, the metal must be thoroughly cleaned before the bituminous paint is used. If coal-tar pitch is sufficiently refined, it gives the paint greater life than does asphalt.

Bituminous paints, because they may be subject to temperature changes and deterioration, are not so satisfactory as a protection against atmospheric corrosion as underwater. This feature is overcome in the manufacture of asbestos protected metal, extensively used as siding to close the temporary ends of power plants. The flat sheets of bare metal are dipped in hot bituminous paint, wrapped with asbestos felt specially impregnated and coated, pressed through rolls applying waterproofing pitch and then corrugated.

A high grade bituminous paint properly applied to a thoroughly clean, dry surface affords an excellent protective coating for iron and steel in contact with water at normal temperatures. Zinc applied by the hot process of galvanizing is widely used also under the same conditions.

### Air Leakage Into Closed Systems

In a closed system the oxygen originally in solution is available to cause corrosion. While central-station power plants operate theoretically on a closed system, this is not air-tight at all points. There are opportunities for the oxygen of the atmosphere to enter the system when the pressure is below atmospheric between the last stages of the turbines, through the condensers to the hot-well pump suctions. While every effort is made to exclude air leakage into the system it inevitably occurs in the best operated plants. The amount of air infiltration may be small and almost negligible in terms of operating vacua, but of considerable magnitude as measured by the quantity of oxygen absorbed and dissolved by the recently condensed water. Industrial power plants, with high percentages of boiler make-up water, can not help but introduce considerable quantities of oxygen into their systems though they do not operate on what may be termed a strictly closed system.

The rate of corrosion increases with a rise in the temperature of the water, if no oxygen escapes. As the pressure of the system increases the solubility of oxygen is increased and, at high temperatures, retains the oxygen dissolved when the water was at a lower temperature. Thus, both pressure and temperature act to increase the rate of corrosion. To reach the walls of the container, the oxygen diffuses through the water and the rate of diffusion is directly proportional to the oxygen concentration of the solution. It will diffuse, also, through the film of corrosion products upon the surface of the metal and the rate is inversely proportional to the film thickness. If the water is alkaline, the rate is less than in a neutral water with the same increase in temperature. Turbulent flow, as usually obtains in pipe systems, tends to increase the rate of corrosion, as the dissolved oxygen brought into contact with the metal is replenished.

Internal corrosion occurs in piping, water tanks, condensers, the low-pressure cylinders of turbines, feedwater heaters, evaporators, deaerators, pumps, economizers, water-cooled furnace walls and boilers. The entire internal surface may be wetted as in the case of pipes, pumps and economizer, furnace wall and boiler tubes or only partially under water, as most tanks, evaporators and boiler drums. Where completely under water the surface is subject to general corrosion, while if the vessel is only partially filled another form of corrosion, known as pitting at the water line, also occurs. The situation is further involved by the range of temperature obtaining throughout the equipment, being a so-called normal in the condensers and some of the tanks and piping and a maximum at some elevated temperature in the economizers, furnace walls and boilers.

Probably the first attempts to retard or prevent corrosion in pipes can be traced back to the earliest days of water conduits when lead pipes were used. Lead is still used today in some instances as a lining for the inside of iron and steel pipe. It may be applied by the electrolytic process or by hot dipping, but the film is generally discontinuous and pin holes are likely to cause pitting of the pipe material if submerged in water. The lining may be applied also as a continuous lead tube on the inside, the surface of the pipe having first been given a hot coating of zinc or tin to which the lead liner alloys in the

process of application. Zinc alone may be used if it is applied by immersion of the article in a hot bath of the metal. A commercial illustration of this means of protection is galvanized pipe, usually coated inside and out as the pipe is entirely dipped into the zinc bath.

### Use of Cement Linings

Cement has been used as a lining, especially in water works' service, where it has proven quite efficient as a protection against corrosion over long periods. The cement bonds to the metallic surface and, while not impervious, any water seeping through to the metal is alkaline. Cement mortar, one part cement and two parts sand, if thoroughly mixed and properly applied in sufficient thickness, is an excellent permanent protective coating for iron and steel subject to underwater corrosion where abrasion by foreign objects is likely to occur.

Steel pipe, desired in many cases because of its strength and ductility to resist failure due to sudden shocks and stresses from water hammer and surges, has been lined with bitumen to afford it internal protection against corrosion. The lining consists of molten bitumen and filler which is applied to the inside of the pipe while it is being rapidly revolved. The material is spread uniformly over the inner surface and adheres tightly, providing a smooth finished, impervious but elastic coat of the desired thickness. This material and process are used extensively, not only as a protection against attack by water corrosion, but also by acids and alkalis in the chemical industry. The lining material has a high electrical resistivity and the tendency to pitting due to stray current electrolysis is greatly reduced.

The foregoing examples of internal protective coatings for pipes are mentioned as illustrations of some of the materials and processes used. There are probably a great many more, equally meritorious, at least under some special conditions, if not under all conditions.

### Control of Water Alkalinity

General corrosion of equipment, especially boilers, is often retarded by maintaining the alkalinity of the water recirculated in the closed systems of power plants. The effect of alkalinity on corrosion is mainly due to the rapid formation of a protective layer of iron hydroxides on the surface of the metal. It is most marked in distilled water and thus obtains in power plants where the make-up water is supplied through an evaporator. The initial rate of corrosion of newly exposed steel in an alkaline water is the same as that in a neutral water, but decreases thereafter as the film of ferrous hydroxide is formed. Hydroxide alkalinity is more effective than that due to the corresponding carbonates or bicarbonates. It may be changed to the latter on exposure to air by combining with $CO_2$. Even though the system is closed it is necessary to maintain the proper alkalinity by the addition of chemicals to the boiler feed water.

### Deaeration Widely Employed

Another available weapon is deaeration. Until the past ten years or so, no efforts had been made to remove dissolved oxygen from boiler feed water to as great an extent as is done in today's practice. Feed-water heaters were vented to the atmosphere to allow the escape of air and non-condensible gases from the system. Deaeration is carried much further now and equipment is available for removing all but 0.025 c.c. per liter of dissolved oxygen from the water. Inasmuch as the concentration of dissolved oxygen is the controlling factor in corrosion in natural water, its removal is of great importance in the life of equipment. If oxygen could be entirely eliminated all corrosion in natural waters would be practically negligible.

Deaeration, liberates oxygen by the mechanical mixture of finely divided water and steam in which the steam vaporizes the water and the dissolved oxygen is thrown out. The process requires a temperature of at least 212 deg. F. and preferably 220 deg. Deactivation is a chemical means of oxygen removal accomplished by permitting it to rust other metal before the water enters a closed system. Deaeration is extensively used in most modern power plants while deactivation has fewer applications in that field.

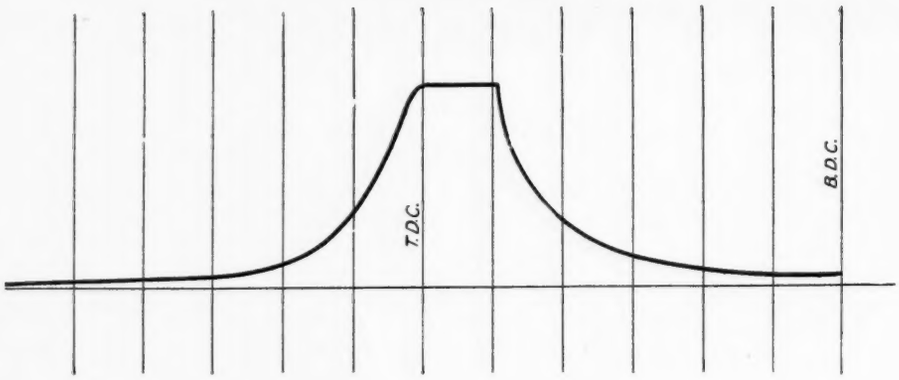
The methods outlined to retard or prevent internal corrosion of equipment have been quite successful as applied and used in power plants. However, the continuity of any of them is not assured and any lapses at once afford opportunities for corrosive attack on vital parts where ultimate failure spells disaster. The chemical and mechanical methods of treating boiler feed water to decrease its activity as a corrosive agent involve the human element, which is not infallible. The condition of the raw make-up water is likely to change suddenly, unknown immediately to the operators, so corresponding changes in the method of treatment are not made. Large and sudden fluctuations of loads and temporary outages of some particuar piece of protecting equipment often upset the established routine of treatment.

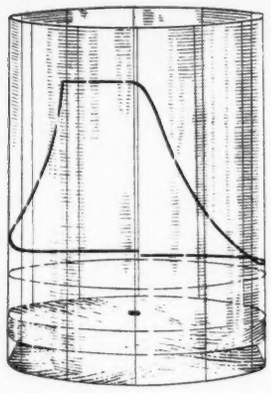
### Application of Internal Coatings

As an added precaution, well worth while, to insure against corrosive attack during lapses of the method of treatment used, the interior surfaces of equipment subject to corrosion should be protected by a film both physically strong to withstand erosion due to water velocity and chemically inert with respect to iron at all temperatures. It should be applied only to surfaces properly prepared, as the film is essentially a priming coat upon the bare metal base, and to an appreciable thickness. Coverage must be made perfect by at least two coats. As the first coat is applied to bare metal it may not afford complete coverage. Commercial pickling of tubes and sand blasting of drums is not always complete and small pieces of mill scale may still adhere to the metal. In the case of internal boiler surfaces which have been in service, there is often a deposit of water scale impossible to entirely remove and perhaps small pits of corrosion already started have not been entirely cleaned out. When such conditions obtain, the application of protective coatings becomes a progressive process to a certain extent. All but a very small amount of the area to be covered can be rendered inactive by the first application and the balance becomes inactive when a second coat is applied.

Such a film over areas already rusted will stop further corrosion if the film is impervious and excludes moisture and oxygen from the area. A protective coating of the kind just described may act also to inhibit the phenomenon known as caustic embrittlement in steel boilers.

In the series of three articles, of which this is the last, the author has not endeavored to exhaustively treat of that phase of corrosion affecting power plants and their equipment. An effort has been made to arouse interest anew in a form of economic waste that occurs everywhere and is ever present. There is much research work yet to be done to supply greater detail to our present knowledge of the laws governing corrosion prevention and assist us in their economic application. The problem is a major one for the engineer.



# Advantages of OFFSET DIAGRAMS In Checking Oil Engine Operation

By P. H. SCHWEITZER

*Associate Professor, Pennsylvania State College*

THE MAJORITY of engineers are familiar with the engine indicator as developed for the steam engine to obtain a record of the pressure-stroke events in the cylinder. The same instrument, with improvements, has been applied to internal-combustion engines, and has given valuable information. Unfortunately, the pressure-stroke diagram, while highly satisfactory for steam engine work, is not so well adapted to gas and oil engines. Therefore frequently a modification is employed, this being the "offset" diagram.

It can be seen from Fig. 2 that while the crank moves, say, 35 deg., the piston moves only from the dead center position, as shown by the heavy outline, to the position given by the broken-line outline. In the steam engine, steam enters the cylinder during this period, so no marked pressure change occurs. But in an internal-combustion engine during this same part of the crank circle, the fuel is ignited and burned and expansion begun. The limited diagram width precludes a study of these varying events. The pencil of the indicator moves rapidly up and down while the drum is at a practical standstill; therefore the events are crowded at the ends of in-phase indicator diagrams. If 10-deg. crank arc corresponds to ½ in. in the middle of the diagram it will correspond to less than 0.04 in. at the beginning; consequently pressure changes of considerable difference near the top dead center look alike on an in-phase indicator diagram.

To show the pressure changes in true proportion the "time card" has been used in which the pressures are plotted on a time or crank-angle basis instead of piston-travel basis. As the crankshaft has a uniform rotation, time and crank angle are in direct relation. A time diagram of a gas engine is shown in Fig. 4, the ordinary pressure-stroke diagram of which is shown on the side. It will be noticed that the combustion line stretched considerably and the pressure curve near the top dead center is less steep than on the pressure-stroke diagram.

Instead of taking a time diagram it is usually more convenient to take an offset diagram, which serves the same purpose. All one needs do is to take the indicator motion from a crank which is 90 deg. ahead or behind the crank belonging to the cylinder to be indicated. In a multi-cylinder engine with cranks 90 deg. apart one may take a crank or connecting rod 90 deg. off to drive the indicator. The indicator then delivers a diagram similar to Fig. 3.

The average engineer stands somewhat puzzled in the front of an offset indicator diagram. Seeing a regular diagram, he mentally compares it with the theoretical one and with actual diagrams of good and bad engines he has seen tested. But with an offset diagram he has little basis for comparison. One has to see a great number of them before being able to study them intelligently.

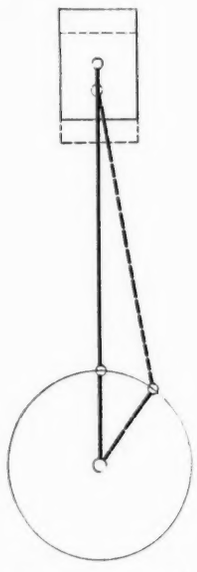


**Fig. 2 — Small piston motion at the beginning of the stroke**

Comparing those portions of the indicator diagrams which are in the vicinity of the top dead center, the offset is very similar to the time diagram. This is because the velocity of the piston at the middle of the stroke is nearly uniform.

A means by which one can visualize the relation between the "time," the "offset," and the ordinary "in-phase" is shown in Fig. 1. Following a suggestion of Prof. K. J. De Juhasz, the

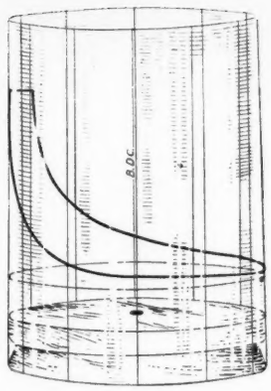



**Fig. 1—(Left) visualizing the relation of a time diagram (A); (center) an offset diagram (B); and (right) an in-phase diagram (C)**

time diagram of a constant-pressure diesel cycle was drawn on a sheet of celluloid as shown in *A* of Fig. 1. A cylinder was formed of the celluloid sheet with the time-pressure on it. Looking at the cylinder in the line of the top dead center, one sees a picture *B* corresponding to the offset diagram. Looking at right angles, one sees the ordinary in-phase diagram as at *C*. They both are projections of the time-pressure diagram planes at right angles to each other. This does not hold strictly with finite connecting rods, but the approximation is close.

This representation also shows why the offset diagram does not differ much from the time diagram near top dead center. Looking from the front, the bending of the celluloid sheet left the portion near the top dead center line practically unaffected.

Diagrams of the theoretical constant-pressure diesel cycle in in-phase and in offset representations are given in Fig. 5. Fig. 6 represents an Otto cycle and Fig. 7 a dual-cycle engine diagrams. The maximum pressure in all the cycles is 625 lb. per square inch. The characteristics of the theoretical cycles in the offset diagram are to be noted.

The time, or its substitute, the offset, diagram, did not come into extensive use until lately, when engineers concentrated attention on the problem of knocking in internal-combustion engines. In carburetor engines it was the increase in compression ratios that brought forth knocking. In diesel engines it was the increase in speed, and engineers early realized that the knock actually occurs right after ignition. The manner of pressure change no doubt has a bearing on the knocking problem. Investigations and accumulated experience show that if the pressure rise is steep the engine is likely to knock, while a gradual pressure rise is characteristic of a smooth-going engine.

The offset diagram therefore offers an excellent means to judge the roughness of an engine. Frequently, the in-phase diagram shows sufficiently that it has been taken from a smooth-going engine. The offset diagram, Fig. 8, simply confirms what is evident from the in-phase diagram, that the engine is an extremely smooth-running engine. On the other hand, the in-phase curves on Figs. 9 and 10 taken from a solid-injection engine are very much alike. Only an inspection of their offset records discloses the fact that the former was taken from a smooth-running and the latter from a "rough" engine. Incidentally, both diagrams are from the same engine, but running on diesel oil and coal-tar oil, respectively. Further samples of rough and smooth diagrams can be seen in Figs. 11 and 12.

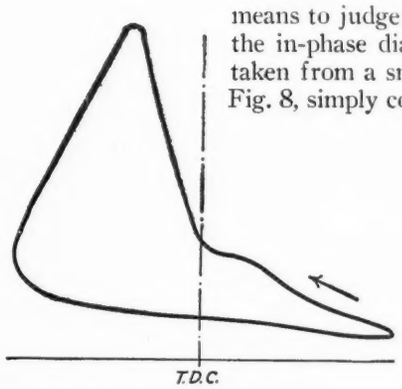



**Fig. 3—Offset diagram corresponding to Fig. 4**

Roughness of an engine is always accompanied by the pressure curves having a steep position after ignition on the offset diagram. But the characteristic of the pressure curve is not always the same. Sometimes the compression line continues into a steeper portion caused by the combustion of the fuel as shown on Fig. 11. Occasionally a step is present as on Fig. 10 and the steep pressure rise follows the step. While the engine would be rough-going in both cases, the offset diagram would help to put an entirely different diagnosis on the trouble.

The undesirably rapid pressure rise in the Hesselmann engine, Fig. 11, was apparently caused by a very fine atomization and rapid ignition. The Koerting en-

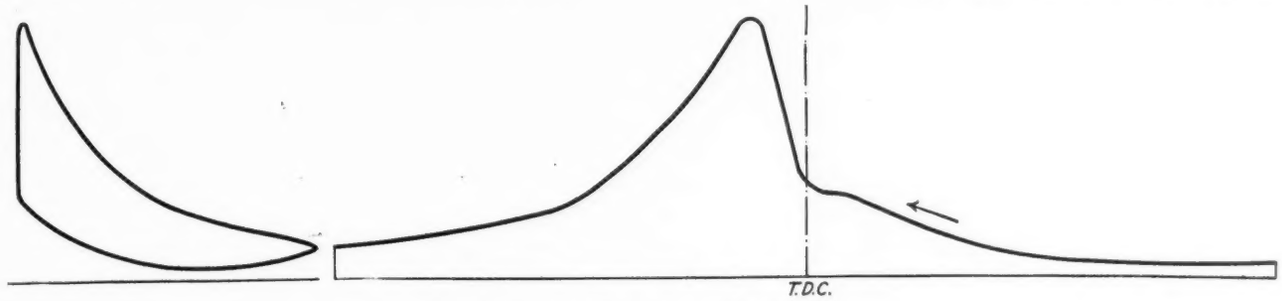



**Fig. 4—Time diagram of a Cockerill gas engine, from which Fig. 3 was also obtained**

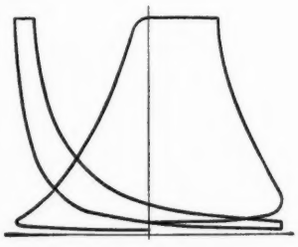


**Fig. 5—Diagram from a constant-pressure diesel engine**

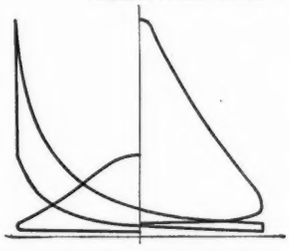


**Fig. 6—An Otto-cycle engine gave these diagrams**

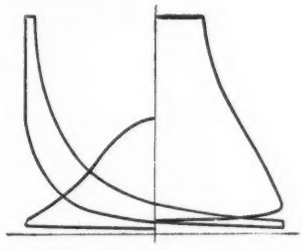


**Fig. 7—Diagrams from a dual-cycle engine**

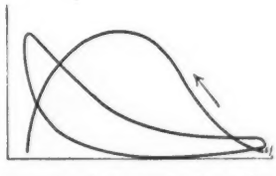


**Fig. 8—In-phase and offset diagrams of an air-injection diesel**

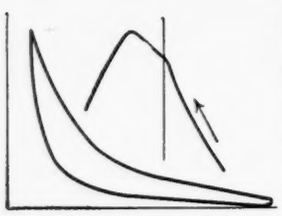


Fig. 9—Indicator diagram from a solid-injection diesel

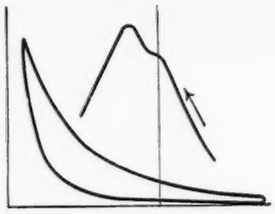


Fig. 10—Diagrams from a rough running solid-injection diesel

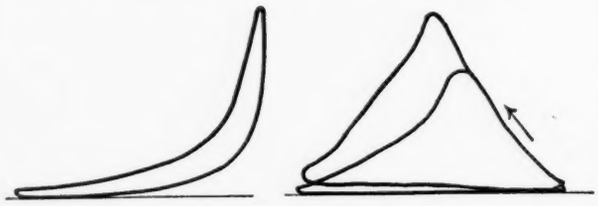


Fig. 11—Diagrams from a Hesselmann diesel, showing pressure rise

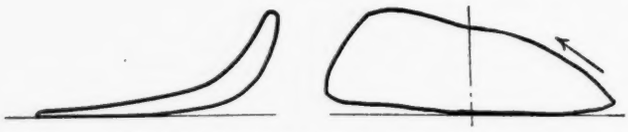


Fig. 12—Diagram from a Krupp engine

gine, Fig. 10, shows the sign of a long ignition lag, and the time lag between the injection and the start of combustion caused a pause in the pressure rise. During this time an appreciable amount of fuel accumulated in the combustion chamber; and when the ignition finally set in this accumulated fuel charge burned at once, causing a violent pressure rise after dead center. Reducing the ignition lag as likely to eliminate the subsequent violent pressure rise with the resulting knock.

Ordinarily, a simple inspection of the offset indicator diagram will reveal the presence of a long ignition lag by a step in the pressure curve after injection. When this is followed by a steep rise the blame is clearly on the ignition lag for causing the knock. An offset diagram showing no ignition step is, of course, more desirable.

▼

# Street Lights Turned On And Off Automatically

A PHOTO-ELECTRIC TUBE that controls nine street-lighting circuits in Albany, N. Y., is a recent product of the General Electric Company. As soon as a certain degree of darkness prevails, regardless of the hour, the photo-electric tube operates a relay, which, in turn, supplies power to throw a switch, turning on the street lights. With the return of daylight the switch opens, turning off the lights.

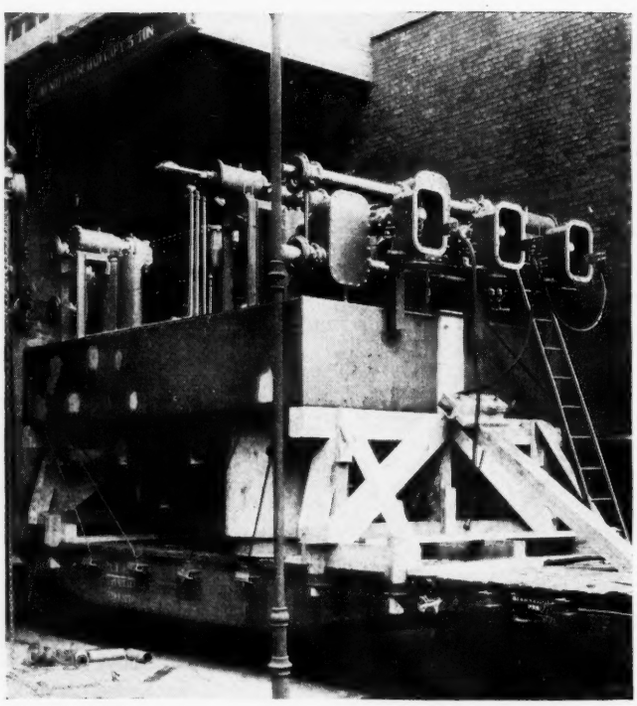
The light-sensitive "eye" of the photo-electric tube is pointed to the north, so that it "sees" the average light and thus avoids direct sunlight. As small a change as one-millionth of an ampere will operate the mechanism. The power consumed in one hour by the street lights on the nine circuits is nearly equal to the average consumption of a residential customer in Albany for three months. In other words, a millionth of an ampere controls about 140 kw. of electric energy.

A very small amount of current flows through the photo-electric tube, the current varying with the amount of light striking the light-sensitive electrode (the more light, the greater the flow of electricity through the tube). This small amount of current is amplified to a degree sufficient to operate the relay. Thermal time-delay relays are included in the equipment to prevent instantaneous operation in response to disturbances such as the passage of a cloud over the sun, a flash of lightning at night, a person walking in front of the unit, etc., but once the contactor has been actuated, it will remain and not "flutter" at the critical light intensity.

The photo-electric tube is more flexible and positive in operation than time switches or manual operation. For example, during the 97 per cent total eclipse of the sun in 1932, when the Albany area will be darkened, the street lights will probably turn on, or, on very dark stormy days, which are common, the lights will turn on automatically. Changes of the seasons will not affect the new system, for the only factors which govern this controller, and the only ones which are important, are light and darkness.

▼

# Factory Testing of Metal-Inclosed Switchgear



RECENTLY, in the high-power laboratory of Westinghouse at East Pittsburgh, switchgear of the outdoor metal-clad type was subjected to four short-circuit tests on all primary circuits, including the oil circuit breakers. On the first test short-circuit current of 50,000 amp. was produced on a 7,600-volt, 3-phase, 60-cycle circuit. Three successive tests were made with increased current until the maximum reached was 143,000 amp. The illustration shows the unit in the testing bay ready for operations.

# How Deion and Deion-Grid Circuit Breakers Operate

By HENDLEY N. BLACKMON
*General Engineer*
*Westinghouse Elec. & Mfg. Co.*

**Two high-voltage circuit breakers, the Deion, an air-break type, and the Deion-grid, an oil-break type, have come into use recently. Although both remove ions from the arc when interrupting a circuit, they operate on entirely different principles**

CIRCUIT BREAKER designers have found their job increasingly difficult and important as the size of electric power systems has increased. Almost anything was good enough at first, even a plain knife switch; and a simple hand-operated plunger switch was still satisfactory twenty years after alternating-current came into use. But as power systems have become more complicated, circuit breakers have grown in importance; certain ones may be called upon to handle the whole generating capacity of a system.

The Deion air-break circuit breaker for moderate voltage and power, and the Deion-grid oil circuit breaker for high voltage and large power, introduced new types of arc-rupturing devices. Despite the similarity of names, the Deion and Deion-grid circuit breakers are totally different devices. They both take ions out of the arc stream so fast that the arc dies, but they accomplish this result in widely different ways. The Deion circuit breaker whirls the arc to death in air. These air circuit breakers are built up to 23 kv., use no oil, and operate by causing the arc to rotate around over metal plates. The arc during this period moves so fast there is no time for burning, while at the same time it is being drained of ions by the cool plates.

The Deion-grid construction uses vaporized oil to blow out the arc under oil. These oil circuit breakers have a voltage range from 15 to 230 kv. and do their work by causing cool gas from vaporized oil to plunge turbulently through the arc and absorb its ions.

Fig. 2 shows one pole of a Deion air-break circuit breaker, on which $D$ is the deionizing chamber and $B$ is one of the arc-control coils that produce the magnetic field to blow the arc up into the deionizing chamber. Another coil is on the opposite side of the breaker. The breaker's contacts are between these two coils and can be seen in Fig. 4, which shows the top part of the breaker

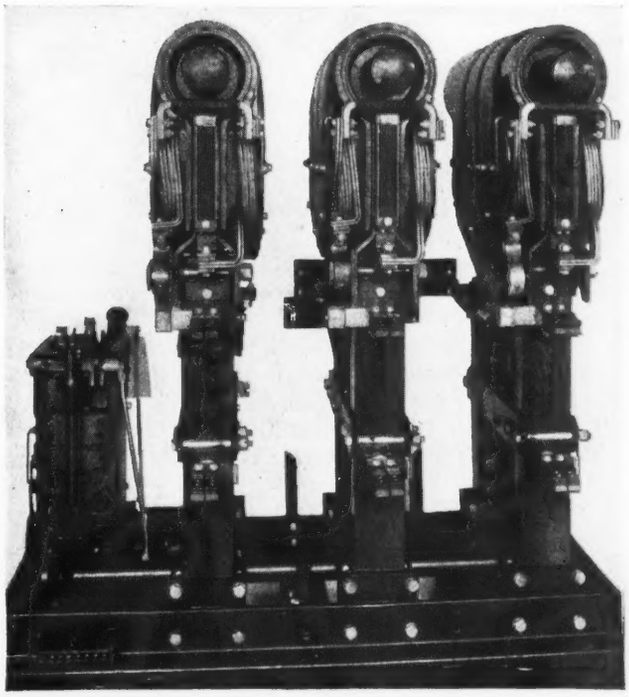


**Fig. 1—End view of a 3-pole Deion air-break circuit breaker**

with one of the arc-control coils removed. $C$ and $C'$ are the main contacts and $A$ and $A'$ are the arcing contacts. When the main contacts $C$ and $C'$ open to interrupt a current at high voltage a vicious arc is drawn. The magnetic field produced by the arc-control coils blows the arc up onto the arcing contacts $A$; first on the points $A$ and $A'$ of the contacts and then up the top edge of the contacts to $E$ and $E'$, from where it leaves and goes up into the deionizing chamber $D$. The deionizing chamber is built up of thin copper plates similar to that in Fig. 3.

The higher the voltage the greater the number of deionizing plates used. The $\frac{1}{16}$-in. space between the plate is good for 250 volts, but in service the plates are worked at about 120 volts. Groups of these plates are assembled with radial coils $R$, Fig. 4, between them. When energized by the potential across the arc the radial coils produce a magnetic field that rotates the arc over the surface of the deionizing plates. The path of the arc can be seen on the plate, Fig. 3. The arc was blown up the slot $S$. When it reached the top of the slot it was cut up into short sections by the plates and then moved in the path $P$ shown, taking a counter-clockwise direction around the hole in the center of the plate. Fig. 5 shows a view looking into the bottom of the slot in the deionizing chamber. As the arc rotates over the deionizing plates it is relieved of its ions and extinguished.

From the foregoing it is seen that with the Deion circuit breaker as in an ordinary industrial contactor, a long, vicious arc forms at the arcing terminals as the contacts

separate in air. A magnetic field pulls the arc up into the deionizing chamber, whose stack of parallel plates chop the long arc into many small ones. The short arcs are rotated between the copper plates until they are extinguished. Specifically, the following things happen in the Deion air-break circuit breaker:

1. The contacts open, drawing a long arc in air.
2. The arc is forced into a deionizing chamber by a magnetic field.
3. The metal plates of the deionizing chamber divide the original arc into many short ones, about $\frac{1}{16}$ in. long.
4. These short arcs are whirled (approx. 40 miles a minute) around a metallic track by a magnetic field.
5. After making about 15 to 30 laps on the cool circular path, the short arcs are drained of ions, and the circuit is broken as the line current passes through zero.

If the $\frac{1}{16}$-in. arcs hesitated $\frac{1}{2}$-second the deionizing chamber would weld together; so the arc must move fast. Although the arc has a temperature of 5,000 deg. F., its speed is so great that a cotton thread held directly in its path is not even scorched. Arcs traveling at ordinary speeds and coming in contact with metal would rapidly melt it and use the metal's ions to prolong its life. In the Deion air-break circuit breaker just the reverse occurs. The cool copper plates instead of giving up ions, take ions out of the swiftly moving arc.

The Deion air-break circuit-breaker is inherently quick-acting. The circuit is interrupted at the first zero of current after the arc enters the deionizing chamber. Heavy currents, 15,000 to 20,000 amp., are interrupted within a half cycle (1/120 sec. on a 60-cycle circuit). For comparatively small currents the magnetic forces acting on the arc are weaker and extinction takes longer. Under this condition arcing often appears in parts of two half cycles; the additional zero occurring while the arc is rising from the contacts to the deionizing chamber.

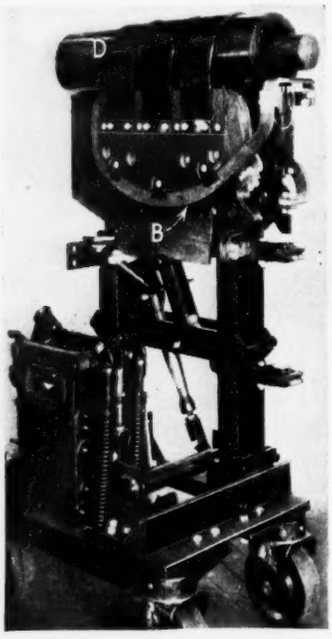
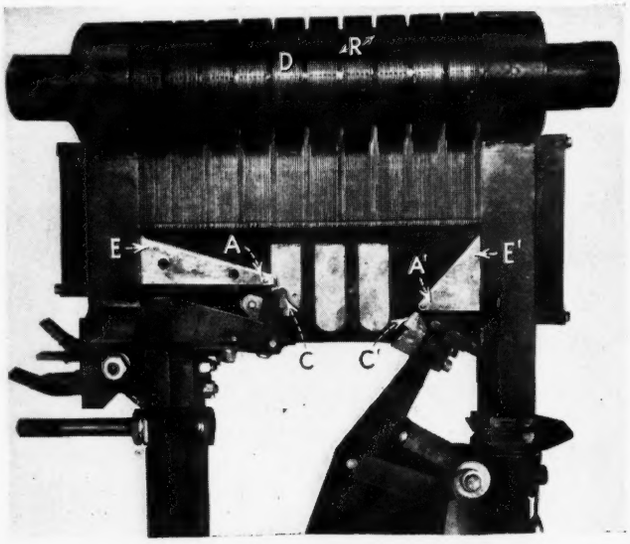


**Fig. 2 (Left)—A single-pole 12,000-volt Deion circuit breaker**

**Fig. 3 (Right)—A deionizing plate; the arc path can be seen at P**

Exhaustive tests over the complete current range down to one-half ampere have been made on Deion breakers. During laboratory rupturing tests 14,000 amp. at 13,200 volts were repeatedly ruptured. In field tests more than 25,000 amp. at 12,000 volts were handled. When tripped by ordinary overload relays, short circuits of 5,000 amp. or over are cleared within 6 to 9 cycles on a 60-cycle system. High-speed relays and special tripping apparatus on the breaker can reduce short-circuit duration to half the above values. Still faster is the 15-kv. Deion high-speed air-break circuit-breaker for railway service, which breaks 50,000 amp. at 12,000 volts in one cycle or less (0.04 sec.), including relay time.

The Deion air-break circuit-breaker has been developed for a wide range of applications. At one extreme is the 1,000,000-kva. 23-kv. design, successfully tested up to 800,000 kva. At the other extreme is a little Deion air circuit breaker with a plate about the size of a watch, of which a group of six repeatedly broke 10,000 amp. at 600 volts, alternating current.



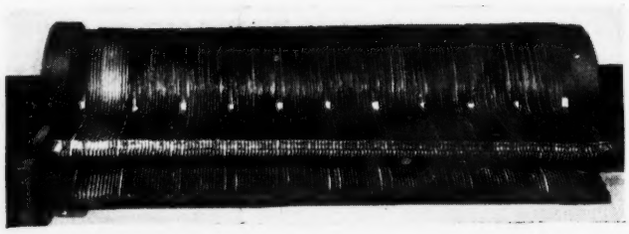



**Fig. 4 (Above)—Deionizing chamber and contacts of a 15,000-volt breaker**

**Fig. 5 (Below)—Looking into the arc slot entrance to the deionizing chamber**

The performance of the Deion grid oil circuit breaker, like that of the Deion air-brake type is due to the quick removal of ions from the arc stream. When the contacts of the Deion-grid oil circuit breaker part under oil the arc is held magnetically to a definite path by its own energy. The path is in oil and oil-soaked material. The heat from the arc instantly vaporizes the oil, and the only way the gas can escape is to pass through the arc.

One plate of a Deion grid is shown in Fig. 7. The dark area is a thin iron plate and the gray area is an insulation plate. A Deion grid shown at *D*, Fig. 8, is built up of several plates such as the one in Fig. 7. When the breaker contacts open, an arc is drawn near the mouth of the slot. Because of the shape of the iron plates the magnetic field around the arc will move to the back end of the slots and will carry the arc with it. When the arc is first formed the slot is full of oil. As the arc vaporizes the oil in the back of the slot the vapor is forced out

through the arc as the latter is pulled back into the slot by the magnetic field. The gas passing through the arc removes ions from it and causes it to be extinguished.

In brief, the following occurs when the Deion-grid oil circuit breaker interrupts a circuit:

1. The arc is drawn under oil.
2. The arc produces a magnetic field about itself, which keeps it to a definite path.
3. The arc's path is a deep narrow pocket of oil entrapped by U-shaped pieces of oil-sodden fuller board.
4. The hot arc vaporizes the entrapped oil.
5. The oil vapor rushes through the arc on its way out.
6. The turbulent blast of gas blows out the arc by taking so many ions from it that it stays out as the current passes through zero.

Until fundamental studies of the extinction of an arc in oil were made, the gas formed in oil circuit breakers was looked upon as a necessary evil, having nothing to do with putting out the arc. Dr. Slepian, however, discovered that oil circuit breakers work only because the gas from volatilized oil releases a flood of un-ionized particles to remove ions from the highly ionized arc. Hence, the Deion-grid oil circuit breaker has been aptly called a gas-blast oil circuit breaker.

The Deion-grid oil circuit breaker uses the generated gas to put out the arc in a very much shorter time than was possible before. The amount of gas formed by an arc in oil depends on the length of time the arc lasts. By generating gas at a higher rate but for a short time, and focusing all the gas on the arc, the arcing time is greatly shortened and the total amount of gas is reduced. Tests have proved the arc is extinguished in a Deion-grid circuit in less than 10 per cent of the time formerly necessary to draw it in oil to interrupt the circuit.

While Deion grids are used with new high-voltage oil circuit breakers, they can also be applied to many oil circuit breakers of older design. They have already been put in service on breakers from 34.5 to 230 kilovolts.

The Deion-grid oil circuit breaker is much more economical of oil than are the older types. Only a small portion of the total oil is used for an arc-rupturing operation, that portion entrapped extinguishing the arc, after which other oil rushes in to fill the groove, to be used, in turn, for the next circuit interruption. In this manner only a small portion of the oil in the tank is exposed to the deteriorating action of any one arc, and a breaker may be subjected to longer service before changing the oil than with the older types. With this design upward of 50 short-circuit tests have been made on a single body of oil without marked depreciation in insulating value.

On test, Deion-grid oil circuit breakers have opened 3,500 amp. at 110,000 volts with 1.5 cycles of arcing and 3,000 amp. at 220,000 volts with 3.5 cycles of arcing or less on a 60-cycle system. Decreased arcing means more satisfactory breaker performance, less deterioration of oil and contacts, and lower maintenance. The stability of the power system is improved, since short circuits are likely cleared before they affect synchronous machines.

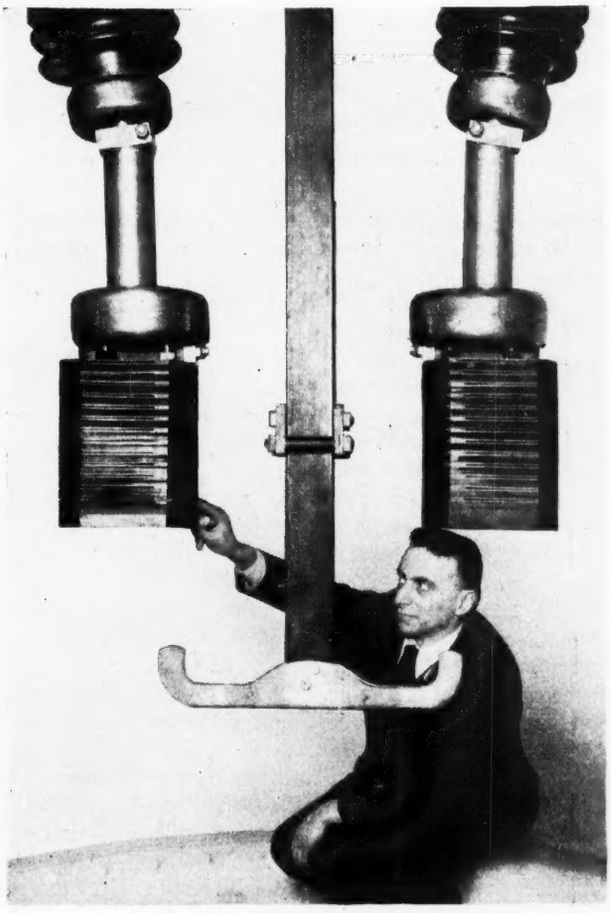


**Fig. 6—Dr. Slepian pointing to the slot in the Deion grid on an oil-circuit-breaker contact, through which the gas escapes**

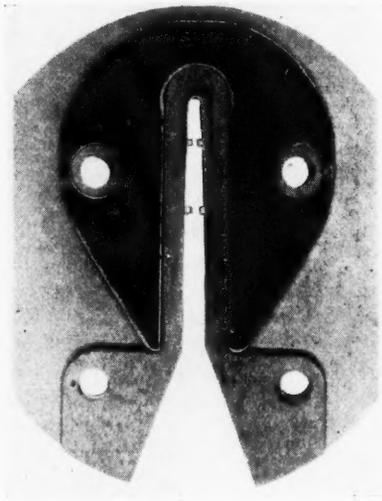


**Fig. 7—Iron plate (dark) and insulation (light) Deion-grid unit**

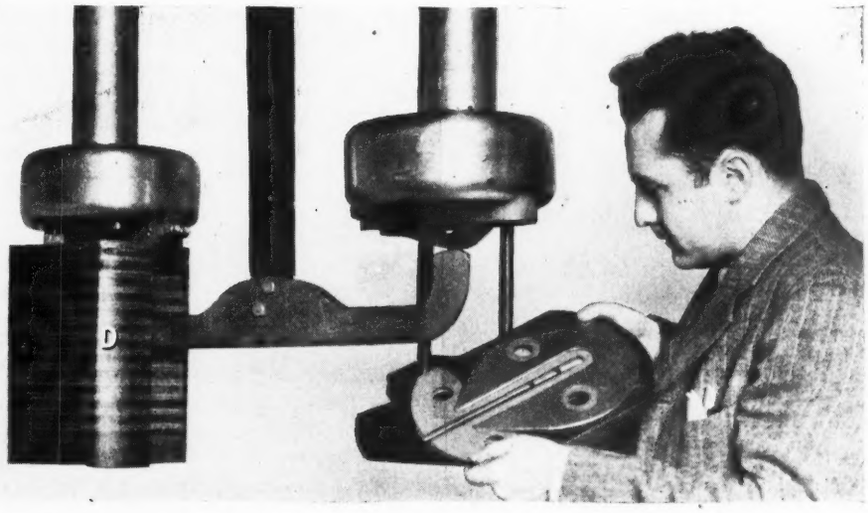


**Fig. 8—Oil-circuit-breaker contacts closed; Deion grid D on one contact and removed from the other**

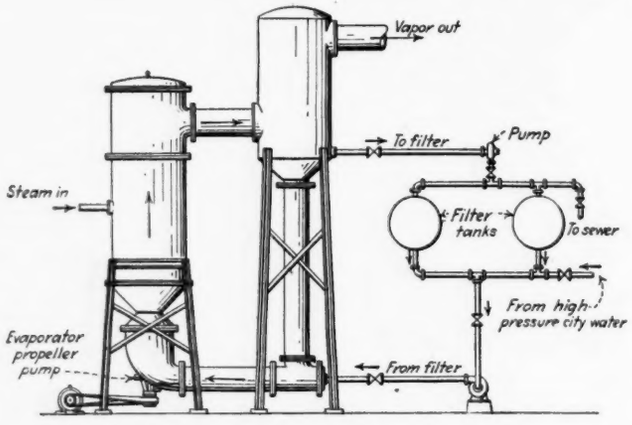
# Improving the Evaporator For Industrial Use

By R. J. GAUDY
*Sessions Engineering Company*
*Chicago*

**Development in this new type of evaporator with continuous circulation, high heat transfer and proportional filtration offers a workable solution to the closed water circuit behind back-pressure turbines, and as an isolated industrial process steam generator in paper, rubber, food-product, and plants where steam or condensate losses impose avoidable costs**

USE OF STEAM for services and processes wherein the condensate is not returnable to the boilers imposes, in many industrial plants, a make-up problem that is both serious and expensive. This problem of control and treatment in certain plants has even made it necessary to forego the higher efficiencies that would ensue from the use of high-pressure boilers.

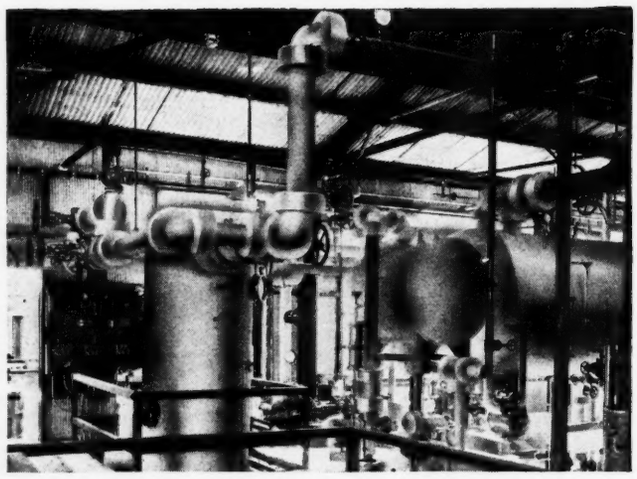
Losses in service, boiler tube damage and high maintenance cost from the use of raw-water make-up have emphasized the advantages of a closed water cycle in the boiler feed system and made the use of evaporators an attractive development. The customary types of evaporators fulfil the technical requirements, but their inherent limitations in heat transfer rate and continuity




**Assembly of new industrial evaporator**

of service appealed to the writer as possible of improvement.

In the usual type of evaporator the water fed into a non-circulating body limits the rate of heat pick-up from the steam tube surface, which contributes to the high capital cost of units for a given steaming capacity. Deposits of scale on the tubes require allowance of added surface to offset the reduction in steaming rate as the deposit builds up. The deposit of the scale within the shell on surfaces from which it will not crack off, periodically calls for inconvenient and expensive cleaning procedure. The necessity of cracking the scale from the tubes at intervals of a few hours imposes not only



**Evaporator and filter, with service and vapor piping**

the cracking cost in labor, heat loss and flooding water, but, more important, requires complete shutdown of each unit in sequence. For continuous service this procedure imposes the necessity of spare capacity in each installation to sustain service.

In the average service battery this feature alone raises the already high initial investment by one-half to one-third, and frequently dictates against the use of evaporators where the benefits otherwise are attractive.

Improvement reduces itself to the provision of a unit that will require no cracking of scale and one that will sustain a high rate of heat transfer. The attainment of these two attributes results in low first cost, simple maintenance and continuous output.

These features were incorporated by the writer in an installation of two evaporator units of a new type made for the Crossett Lumber Company, of Crossett, Ark. As indicated in the accompanying illustration, the design involves continuous proportional filtration to eliminate scale, and continuous circulation of the water at high velocity through the tubes to improve the heat transfer.

To develop byproduct values fully the Crossett Lumber Company has allied to its lumber mill operation, the Crossett Chemical Company, which produces by distillation such products as charcoal, solvents and oils from wood classified as mill waste. Process requirements call for steam at 175 and 100 lb. pressure. The temperatures of distillation are precise and, as in many processes, are controlled by the pressure regulation of saturated steam.

A central power plant supplies steam at 210 lb. pressure to the chemical plant terminal. The closing of the return system to the boiler plant and the return of the recoverable vapor condensate substantially reduces the pounds of raw water make-up to the boilers when serving the chemical plant load.

There are two independent evaporator units. One unit, supplying 10,500 lb. of vapor per hour at 175 lb. pressure, has 419 sq.ft. of wetted-tube surface. The other unit, supplying 15,000 lb. of vapor at 100 lb. pressure, has only 110 sq.ft. of wetted-tube surface. On a continuous run the latter unit averaged a heat transfer of 3,300 B.t.u. per square foot while supplying 15,300 lb. of vapor per hour. These results demonstrate real capital economy when compared with the limitation of present equipment guarantees to heat transfer values of 500 to 800 B.t.u.

To obtain the heat transfer rate given, the water velocity through the tubes must be high and the design

so proportioned that the velocity is assisted by the down-feed head and the absence of scale owing to the scouring action in the tubes.

In starting up the unit the mechanical circulation by the outboard propeller is so effective that the unit noiselessly develops, from room temperature, 100 lb. vapor pressure in the steam dome 30 sec. from the time of first admission of the steam to the shell.

As in the tank type of evaporator, a large volume of water at the flash point is available for sudden load draft, but the rapid recuperation, as demonstrated in starting, makes the unit more responsive to control against time. The scale problem is eliminated by the application of a continuous proportional circulating filter. This Ralston filter, with its full-pressure-packed, double, low-head pump has been applied successfully to the removal of scaling precipitates as formed in boilers, and is even more effectively applied to the evaporator problem where the water circulation is positive and the tube metal temperatures lower. The continuous deposit of scale-forming precipitate in the filter bed results in concentration within operable values, and the backwashing indicated by bed resistance in no way disturbs the continuous, full-capacity operation of the unit.

A standard feed-water regulator maintains the water level. The steam input for constant load is hand controlled. Automatic steam admission controlled from vapor pressure is available for swinging loads. The engineering details of shell design, volumes, stream proportion, air removal and water velocities vary with the conditions of service.

The complete development and construction design was made by the Sessions Engineering Company, and the erection in the field was handled, as is true of all expansion programs undertaken at this plant, by the owner's staff.

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# Salts in Boiler-Feed Water Reduce Priming

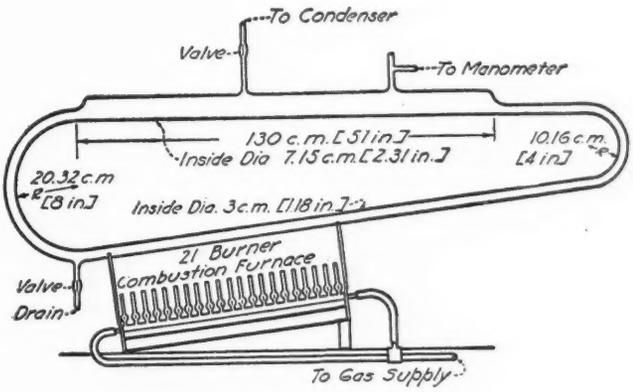
By C. W. FOULK
*Professor of Chemistry*
*The Ohio State University*

THOSE WHO have had much experience with steam boilers know that there are many mysterious cases of the throwing of water into the steam (foaming and priming), that is, water goes into the steam without any apparent reason. Now, it follows in all probability that there are also cases in which water is not thrown into the steam, although according to all that is known of the behavior of boiler water it should be. Priming is being studied as part of the work of Engineering Experiment Station Project 103, the investigation of boiler feed waters.

An experimental steel water tube boiler with the tubes entering the ends of the drum was used in the investigation and it was discovered that the water thrown into the stream decreased as the concentration of dissolved salt in the boiler water increased. In other words, if distilled water or a very dilute solution of sodium chloride or sodium sulphate was used, a great deal of liquid water was thrown into the steam, but if the concentration of the dissolved salt was increased, less water went over into the steam, other conditions, of course, being kept constant. Such a state of affairs is almost unheard of, and it became, therefore, not only very interesting, but also very important, to find out just why this occurred.

A Pyrex glass boiler of the same design and nearly the same dimensions as the steel one was constructed. A glass boiler could not, of course, be operated at high pressures, but since the phenomenon in question occurred at pressures of 10 to 15 lb. and even at atmospheric pressure the necessary conditions could be obtained. As soon as this glass boiler was used it was seen that the reason for the strange occurrence was purely mechanical. A series of waves was propagated along the length of the steam drum, and when the crest of one of these waves hit the steam outlet, water was thrown over. It was further noted that these waves were higher in the case of distilled water or very dilute salt solutions than in the case of the more concentrated solutions. The explanation of the strange behavior was therefore at hand; the throwing of water into the steam line was due to these waves, and the waves became lower, and, of course, hit the steam outlet less frequently, as the salt concentration increased.

The next step was to explain why the waves were lower and flatter in the case of the strong salt solutions. The explanation is that when distilled water or dilute salt solution is boiled, the steam bubbles, though small at first, merge together into large bubbles, and when these large bubbles emerge from the water tube into the drum they set up a series of surges or pulsations which cause the waves along the drum. When stronger salt solutions were employed in the boiler the small steam bubbles did not coalesce, but remained small, and therefore, when they emerged into the drum, did not set up such pulsations. It is interesting to observe in passing that the theory of why bubbles produced in a strong salt solution do not coalesce to form larger bubbles was worked out in the Department of Chemistry.




**Experimental glass boiler used in the tests**

Photographs were taken of the steam in its passage through the water tube. Exposures of about 1/600 of a second were used, and photographs were obtained showing that the small steam bubbles in the case of the strong salt solutions actually remained small and did not coalesce.—*Engineering Experiment Station, Ohio State University, Columbus, Ohio.*

# Research in Power and Allied Fields

IT WILL BE RECALLED that the May 26 Number of *Power* this year was devoted entirely to research and contained a 27-page bibliography of current and recently completed research projects in the field of power generation and its allied services. The compilation included a large number of foreign as well as domestic investigations, but additional data were received from abroad too late to incorporate in the table. Many of these dealt with fuels and smoke elimination.

Publication of this special number also resulted in the receipt of information concerning other research projects being carried on in this country. All this additional information has been assembled into a supplementary bibliography which follows.

Reader reception of the Research Number, judged from comments received, has been so favorable and has displayed such keen interest in the subject of research, as to suggest the idea of publishing lists of new research projects from time to time; or, if the situation warrants, another such number at some future time. To this end the assistance of readers in keeping us advised of new projects will be most helpful.

## ADDITIONAL RESEARCH PROJECTS

Tabulation supplementary to that appearing in May 26, 1931, Number

| Project | Location of Research—Directed by | Sponsor | Status and Published Results | Remarks |
|---|---|---|---|---|
| Laboratory testing of oil stability. | Bureau of Standards. R. C. Hardy. | Bureau of Standards. | Nat. Petroleum Assn., June 6, 1930. *Motive Power*, Aug., pp. 31, 34. | |
| Reports on reclaiming crankcase oils. | Bureau of Standards. | Bureau of Standards. | The *Oil & Gas Jour.*, Vol. 28, Nov. 21, p. 165. | |
| Effect of temperature and fatigue on strength of castings. | U. of Manitoba; Prof. R. W. Moffat. | National Research Council of Canada. | In progress. | |
| Determination of losses occurring in one pressure stage of a turbine. | Breslau Technical U. Lab.; Hans Faltin. | Breslau Technical U. | In progress. | In this turbine both the stationary guide diaphragm and the rotor are adjustable with respect to each other. Observations were made with heat drops between 2 and 60 cal. and different clearances. |
| Research of methods in use for determining the amount of fly-ash contained in exit gases of steam boilers. | Breslau Technical U. Lab., Wolfgang Fahrenbach. | Breslau Technical U. | Completed 1930 | Checking accuracy of dust determinations by glass separators at different gas velocities. Determination of dust distribution in the boiler checking results with Stokes equation. Applying results to draft observations and cyclone. |
| Investigation of dust recovery from coal-fired boilers with wet filters of the Honegmann system. | Technical U., Aachen, Germany; Prof. Paul Langer. | Technical U., Aachen. | In progress. | |
| Calibration of smoke charts. | Fuel Research Div., Dept. of Scientific and Industrial Research, London. | Fuel Research Div., Dept. of Scientific and Industrial Research. | Completed 1929; *Fuel Economy Review*, 1930, 9, p. 97. | |
| Thermal properties of petroleum products. | Bureau of Standards; C. S. Cragoe. | Bureau of Standards. | Bureau of Std. M. 97, 1929. | |
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|---|---|---|---|---|
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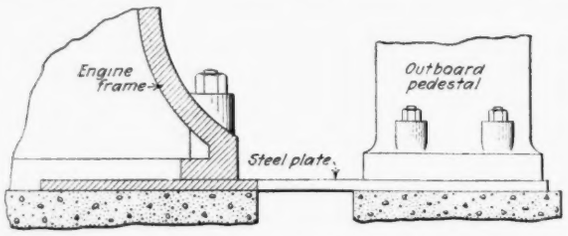
# . . . RIGHT OUT OF THE PLANT . . .

## Improving Contact of Engine Bed with Foundation

AN ENGINE operating on producer gas had its crankshaft running in three bearings, two of which were integral with the main frame, on either side of a center crank, while the third was set upon a separate foundation. The arrangement proved troublesome; the main foundation persisted in settling faster than the foundation of the outboard bearing, and chronic heating of the three bearings was the result. The evil was much intensified by reason of the scant area of contact which the main frame made with its foundation.

The difficulty was rectified by jacking up the machine and slipping two plates of ½-in. steel beneath its bed




**Steel plate inserted beneath engine bed and pedestal**

longitudinally with the main foundation. Slots cut in each plate accommodated the foundation bolts. The plates were long enough to bridge the gap between the main and auxiliary foundations and pass beneath the pedestal of the outboard bearing. The effect was to give the base an area of footing approximately four times greater than it had in the first place. Thus the concentration of stress per unit of area was much reduced and the stability of the foundation improved.

St. Louis, Mo. A. J. DIXON.

## Hand-Scraping Oil Engine Bearings

THE EDITORIAL, "Hand-Scraped Bearings," on page 727, and the article on page 742-43 of the May 12 number of *Power* is highly interesting in view of the recent developments in oil engine construction. The author points out that once a definite speed of rotation has been attained the shaft rides upon an oil film, and to preserve this oil film a fair bearing surface is necessary; also the creation of this film is deterred by roughness of the surface of either the journal or the bearing at the line of contact.

But is this wholly correct?

Assume a truly ground cylindrical crankshaft and correctly hand-scraped bearings in contact: These bearings when examined by a powerful glass will be found to be covered by minute bearing points, the spaces between these points running diagonally from each end of the bearing, thus insuring continuous and free circulation of the oil film. To eliminate hand scraping of engine bearings on the heavier classes we must first perfect the design of the engine bed for the purposes of production and maintenance. There must also be taken into consideration the methods that can be employed economically to produce an oil engine bed and bearings in correct alignment so that hand scraping is unnecessary.

While the modern machine tool produces accurate work, it can only meet the requirements of the oil engine when it is provided with the necessary equipment to insure the correct relation of housings or pockets for bearing shells to machined top of bedplate. When discussing the planing of oil engine bedplates it must be remembered that some firms also machine the base of the bedplate after finish-machining the top. Others first rough-machine the top of the bedplate, then machine the base and then finish-machine the top. These machining processes release the internal strains in casting, and their aid in obtaining correct alignment need not be emphasized.

To obtain the greatest benefit from these machining processes the main bearings should be cast with rigid supports. In marine oil engine practice strict attention is paid to this detail in design because of the external and internal forces encountered. Attention to this point prevents deformation of bearing pockets while the engine is in service and assists toward the easy replacement of shell bearings. While the automotive builder can spend freely on machine tools, jigs and fixtures, the builder of the heavier type of oil engine is handicapped by the comparatively limited demand for his product. Nevertheless, I think a more extended use could be made of the floating drive for the boring bar, and the steadies used to support the boring bar could be fitted with spherical bearings. This would make the bars self-aligning. Ball bearings would give more satisfaction, but where a number of different sizes of engines are being built the cost of such bearings would be a heavy item.

The bearing shells also play a prominent part in the question of correct alignment, but in the choice between the solid shell (halved after finish-machining) and the half bearing shell, most engine builders consider that the last-mentioned gives the best results if the necessary care is given to the machining operations. One method of boring and turning half bearings is: First finish-machine the joints; then lightly sweat the halves together; grip in lathe chuck and finish bore about ¾ of an inch of the bearing bore; also finish the radius. Next fix the spigot jig on the lathe faceplate and fit the bored part of the bearing on the spigot; lightly clamp in place and complete finish of bore. The outside diameter of the shell should be rough-machined during the first operation. Place the

bearing on a mandrel between lathe centers and finish the outside diameter, length and radius. The mandrel is made shorter than the bearing to allow cutting to length and machining the radius. Also, it is turned with about 0.004 in. taper to allow tapping on of the bearing and driving against pressure of cut. This method has given satisfaction in eliminating distortion and hand scraping.

Another method involves the use of an accurate machined mandrel. One half of the bearing is secured on the mandrel by clamps on the flanges of the bearing. The finished machined joint of the bearing rests on the flat surface of the mandrel and the body of the bearing is machined between the flanges to diameter and width. The flat bearing surface of the mandrel coincides exactly with the height of the lathe centers, insuring an exact half bearing. After the halves have been machined on the outside diameter a special chuck is fixed to the lathe faceplate, the halves are placed in the chuck and the bore and flange finished correct to size and in correct relation to the outside diameter of bearing. To turn the second flange the bush is reversed in the chuck. Mandrels for use on accurate machined parts should be fitted with hard steel centers.

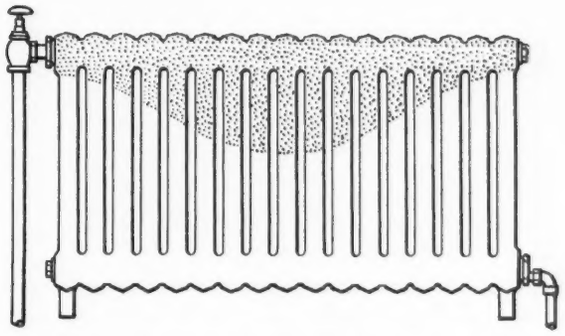
When discussing replacement of bearings by the operating engineer, it must be remembered that lack of rigidity in the support of the bearing pockets will nullify all the efforts of the engine builder to produce interchangeable parts. This defect in design will cause deformation of the bearing pockets through the heat generated while the engine is running and will be considerably aggravated by the knocking which is likely to occur. Hence a partial adoption of the marine oil engine practice in more rigid support of the bearing pockets in oil engines designed for land use is worth considering.

Glasgow, Scotland. DONALD RAEBURN.

## Effect of Turbulence in Steam Radiators

I HAVE READ with interest the article entitled "Effect of Turbulence on Mixture of Steam and Air in Radiators," in the June 9 number of *Power*. This article and the illustrations, which show temperatures in a steam radiator at various points on the radiator surface, indicate clearly that distribution of steam throughout the radiator is more uniform when the radiator is equipped with an orifice at the inlet than when it is not so equipped. Apparently this is due, as the writer indicates, to the steam's being admitted to the radiator through the orifice at high velocity, causing turbulence within the radiator and a consequent mixing of steam and air.

The conclusion that a radiator heats up more evenly with orifice control appears to be a contradiction of the claims made by various companies marketing steam control systems employing radiator orifices, their claim being that only a fractional part of the radiator closest to the valve connection is filled with steam when a fraction of the full steam pressure is supplied to the orifice, and that the radiator is not quite completely filled even when the full steam pressure is supplied. In such systems the orifice is designed to admit only as much steam as the radiating surface will condense even when full pressure is supplied to the orifice; consequently no steam will ever reach the discharge connection from the radiator; and therefore only water of condensation will flow from the radiator into the return piping. It is logical to assume that the thermal element in the radiator



Steam distribution with orifice in valve union

trap will never be heated sufficiently to close the trap, and that since the trap remains open at all times the thermal element may be removed and the radiator operated with an open return connection. Removal of thermal elements from radiator traps would, of course, permit a large saving of the labor expended in cleaning and replacing radiator traps. This saving in operation and maintenance of a steam heating system is a sizable item even when compared to the major saving of steam that can be shown with orifice control. According to the article referred to, the improved circulation of steam in the radiator will of necessity raise the temperature near the discharge connection above what it would be without orifice control. Thus it appears that steam is more likely to reach the radiator trap than it is when no orifice is used.

The elimination of the thermal element in the radiator trap is not theoretical. Large heating systems are actually operating at the present time without thermal elements in the radiator traps. The cap of these traps may be removed even when full steam pressure is being supplied, and it can be seen that there is no steam, but only condensate, discharging into the return piping.

How can this apparent contradiction in actual operation with orifices be explained? C. P. BENNECHE.

New York City.

## Heating a Solution With Superheated Steam

WITH REFERENCE to the answers published in the June 2 number on the question of using superheated steam at 400 deg. to heat a solution to 375 deg. F., steam of the superheat specified cannot successfully be employed to do the work required in a closed heat exchanger with trapped condensate outlet because the differential temperature head (25 deg.) cannot be maintained for sufficient time. If the exchanger can be used as a closed desuperheater, and a use found for the resultant wet steam, the solution can probably be brought to a final temperature approximating 370 or 375 degrees.

The foregoing assumes that the liquid is in motion through the tubes of the exchanger. If the solution is in a stationary bath the theoretical final liquid temperature is the superheat temperature itself. In any event, it is decidedly uneconomical to attempt to raise the bath temperature higher than saturation temperature with steam at so low a superheat value at 42 deg., because of the extensive pipe and bath lagging required.

Buffalo, N. Y. E. C. KEEFE.

## Proper Settings of Superheater Safety Valve

WITH REGARD TO THE QUESTION, "At what boiler pressure should the superheater safety valve be set?" several replies to which were published in the July 14 number, the relation between the load on the superheater safety valve and the load on other safety valves of the boiler to which the superheater is connected is of special interest in view of the necessity of operating the modern high-pressure steam plant with a small margin between the normal pressure and the safety-valve pressure. It is well that there be a clear understanding that the safety-valve pressure, whether the safety valve is on the superheater or on the boiler, is measured by the boiler pressure gage, because the pressure within the superheater will vary as the flow of steam varies, although the boiler gage pressure may be unchanged.

A few years ago, before boiler pressures, temperatures and rates of evaporation were so high, the superheater within the boiler setting was provided with a safety valve in special cases only, although it was the custom to keep the superheater flooded while the boiler was being brought up to operating pressure. The superheater was not exposed to the extremely high temperatures encountered today, nor was it made of material having special heat-resisting properties.

The superheater of the high-duty boiler of today is not flooded during steam-raising periods, although the furnace temperature during the time pressure increases from 590 to 600 lb. must be as great as while the pressure increases from 600 to 610 lb., and the time consumed will be approximately the same. Therefore, if the superheater, through which there is no flow of steam just prior to the opening of the main stop valve, is not damaged as the result of high temperatures, there is no reason to expect damage to occur during a similar time just after the stop valves have closed, especially when the time involved in either case is exceedingly short.

The superheater safety valve is credited with being a part of the boiler safety valve equipment and to that extent, which must not exceed 25 per cent of the total safety valve capacity required for that boiler, is a safety necessity. But so far as the superheater is concerned, the purpose of the safety valve is to establish a flow of steam before damage can result from overheating if the ordinary demand for steam ceases.

There is a pressure drop through the superheater which may amount to 20 or 30 lb., depending upon various conditions, when the boiler is operated at high ratings; but during that time there is no need of a safety valve, so far as preventing overheating is concerned. As the demand for steam decreases, the pressure drop through the superheater decreases, until at a steam flow equal to 25 per cent of the maximum evaporation the pressure drop will probably disappear entirely and the superheater pressure and boiler pressure will be equal.

If the furnace temperatures are properly controlled the superheater safety valve and the boiler safety valve should not operate and the flow of steam through the superheater should be sufficient to prevent overheating. If the boiler-furnace temperatures have not been controlled the operating pressure will increase until one or more safety valves open.

If the superheater safety valve is set to operate first, or at the lowest pressure, that valve acts as the pilot, or alarm, safety valve and does the intermittent blowing as the demand for steam causes fluctuations in the pressure. Superheated steam escapes, which is undesirable and injurious to the safety valve. It is therefore necessary to decrease the normal operating pressure at low load to prevent the operation of the superheater safety valve.

On the other hand, if one of the boiler safety valves operates first—at 600 lb. pressure, for instance—that safety valve acts as a pilot, or alarm, valve; while the superheater safety valve, which may be set 3 to 5 lb. higher than the first safety valve of the boiler, would not open until the boiler safety valve had failed to take care of the increase in pressure.

When one of the boiler safety valves operates first the escaping steam is saturated, with less injury to the safety valve. The maximum normal operating pressure at low load can be 3 to 5 lb. higher than would be possible if the superheater safety valve opened first.

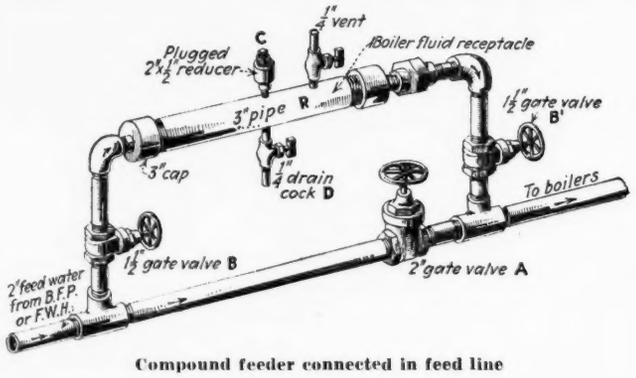
In case of a further decrease in load, or cessation of demand for steam through the superheater, the pressure increase would be practically instantaneous and the superheater safety valve would open, causing a flow of steam through the superheater until the furnace temperature decreased.

There appears to be every advantage in having the safety valve on the superheater adjusted to open at a pressure slightly above the pressure to which the earliest safety valve of the boiler is loaded. M. P. JARED.

New York, N. Y.

## Boiler Compound Feeder

IT IS OFTEN DIFFICULT to decide at what point in the feed pump line the boiler compound should be introduced in order to obviate any reaction between the compound and pump assembly, packing, etc., and aëration of the feed water. The simple arrangement shown permits the delivery of the required amount of fluid into the boiler without contact with pump and in as small quantities or drops as desired. The diameter and length of the receptacle $R$ should be made to suit the quantity of fluid to be introduced daily, and the degree of opening of gate valves $B$ and $B_1$ will determine the amount passed through hourly. To replenish the compound in the receptacle $R$, gate valve $A$ is opened full and gate valves $B$ and $B_1$ are shut, and drain cock $D$ is opened until all liquid empties. Then the vent cock is opened, plug $C$ removed, drain cock $D$ is shut and the compound solution poured in until it shows at the vent. Then the vent is shut, the plug screwed in and valves $B$ and $B_1$ cracked to the degree of opening required. L. W. Ross.




**Compound feeder connected in feed line**

Toronto, Canada.

# Conductors for Heavy Alternating Currents*

**Current-carrying capacity of flat-bar and tubular-bus constructions are analyzed and a new type using aluminum channels arranged to form a square is described**

By D. I. BOHN
*Electrical Engineer,*
*Aluminum Company of America*

and H. W. PAPST
*Engineering Department,*
*Westinghouse Electric & Mfg. Co.*

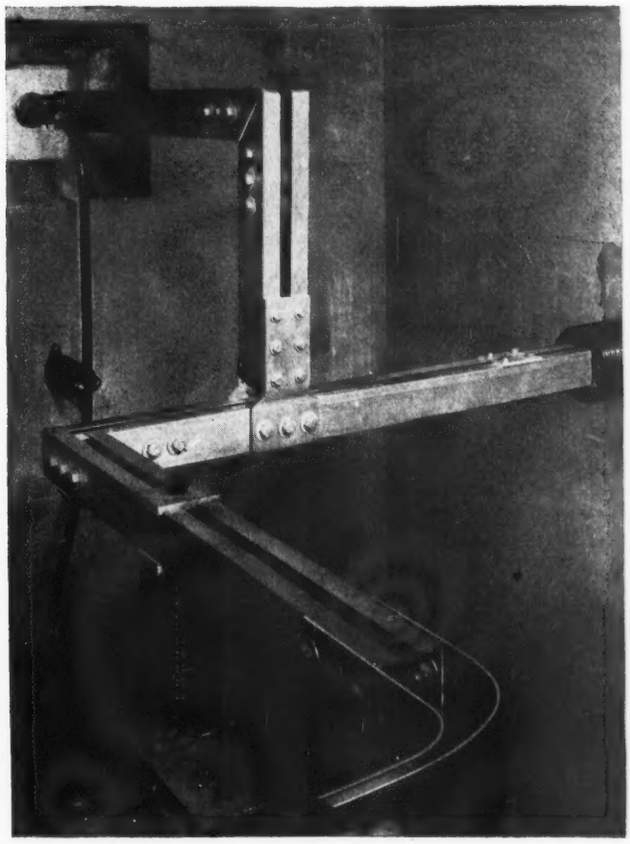


**Fig. 2—Section of the aluminum channel 13,200-volt bus in Chute-a-Caron plant**

INCREASING attention is being given to the design of heavy alternating-current conductors. Loads have in many cases reached a point where reenforcement of conductors alone will not provide the desired extra capacity. It is desirable to limit the conductor temperature rise to 30 deg. C., largely to assist in maintaining reasonable temperatures of connected equipment.

Direct-current conductors have not been a great problem, as the usual practice has been to determine the quantity of conductor material on a basis of a fixed current density, which for the usual flat-bar, laminated design results in an efficient, reliable installation.

With the adoption of alternating-current equipment, heavy-current conductors became very much of a problem. A single conductor made up of a number of laminations is definitely limited in capacity if safe temperatures are not to be exceeded. As an example, it is definitely known that six or even more, 4x¼-in. copper bars spaced ¼ in. apart, with faces vertical, will not carry over 3,000 amp at 60 cycles and stay within rated temperature rise.

Skin effect and proximity effect distort the reactance of individual laminations comprising a single conductor, so that one lamination carries more current than others. This may be illustrated by the diagram, Fig. 1, which shows ten bars in parallel, each 3x⅛ in. and spaced ⅜ in. apart. The flux linkages about this conductor may be shown as concentric circles. Bars near the center of the group have the greater number of flux linkages around them, and consequently the highest reactance. These bars will carry less current than those farther away from the center in order to have the same voltage drop over a given length of bus. Proximity effect is a distortion due to the magnetic effect

*Paper presented at the Cleveland convention of the Association of Iron and Steel Electrical Engineers, June 15 to 19, 1931.

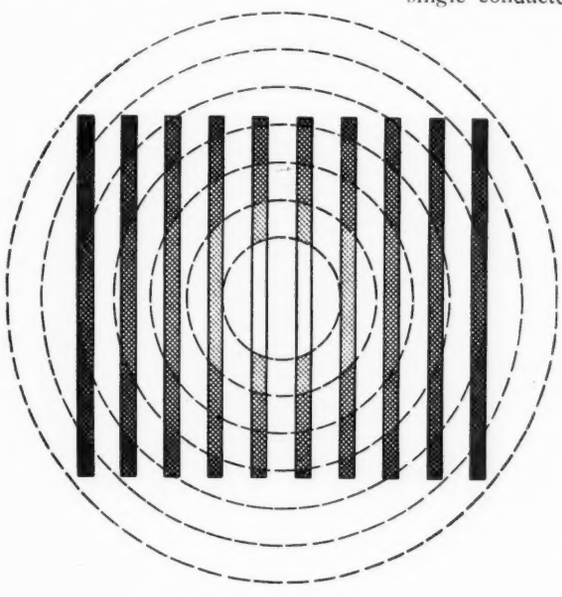


**Fig. 1 — Cross-section of a bus comprising ten 3x¼-in. bars; dotted circles indicate magnetic flux linkages.**

**Fig. 3— (Below) — Vector relation and values of current in the laminations of the bus, Fig. 1. The difference in the current in the two sides of the bus is due to the effects of the return phase adjacent to No. 1 bar**

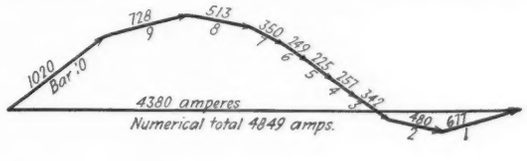


**Fig. 4—Low-voltage, 6,000-amp.,440-volt, 60-cycle aluminum-channel bus installed in an aluminum plate mill at Alcoa, Tenn.**

of one conductor on another, and actually need not be considered if ample space is provided between conductors—or phases if a three-phase system is being considered.

The current in a bus like Fig. 1 and that in the individual bars was measured. The vector diagram, Fig. 3, shows an arithmetic total current for the individual bars in the bus of 4,849 amp., whereas the net or resultant current was only 4,380 amp. The difference, usually spoken of as circulating currents, causes unnecessary heating. The bars at the center of the group could be omitted without changing the net capacity of the bus.

From the standpoint of skin effect, tubular conductors have been considered ideal. A tube, however, does not provide as much heat-dissipating surface as a laminated conductor for the same amount of material. For this reason a laminated bus may be designed to carry more current for a given temperature rise than a tubular bus.

It has been proved mathematically and verified by test that for 60 cycles a tubular conductor may carry more current than a solid rod of the same material and the same outside diameter. For the larger size tubing there is a maximum wall thickness beyond which any increase is not accompanied by an increase in current capacity, as shown by Fig. 5. Standard iron-pipe size tubes are usually used. Their maximum recommended ratings are given in Table I.

Flat bars can be arranged to partly offset skin effect and secure higher capacity per unit of conductor area than in the arrangement in Fig. 1. The modified hollow-square bus design, so called because flat bars are arranged to approximate a square, has relatively high capacity. In this arrangement all major surfaces are kept vertical to obtain the best heat dissipation by convection. Current ratings for various arrangements of the modified hollow-square bus design are given in Fig. 6.

The desirable mechanical and electrical features of both bars and tubes have recently been combined in a conductor design consisting of two aluminum channels arranged to form a split hollow square; see Figs. 4 and 7. Tests showed a low skin-effect ratio, it being comparable to a tube in this respect. Table II gives ratings of various sizes of channels arranged as in Fig. 7.

Expansion problems have never been serious with flat-bar construction, as their flexibility takes care of its adequately in most cases. The rigidity of channels as compared with bars indicated that provision should be made for expansion. Fig. 7 shows a type of bus support that was developed for this purpose. It is so designed that the channels are free to move longitudinally, a small clearance being provided between them and their supporting member. When rigid support is desired, leaving the washer out of the assembly and tightening the main clamping screw will hold the channels rigid.

In many cases, particularly where severe short-circuit currents are not involved, spans of 15 to 25 ft. between supports may be used. Where the phases are arranged vertically with respect to each other the great rigidity of the channels in this direction will in most cases permit these long spans, even where heavy short-circuit currents may occur. Where the phases are arranged horizontally the channels may be fastened together at points in the span to provide, in effect, a truss. This may be done either by bolting a small plate to the flanges or by using a bus support without the insulator.

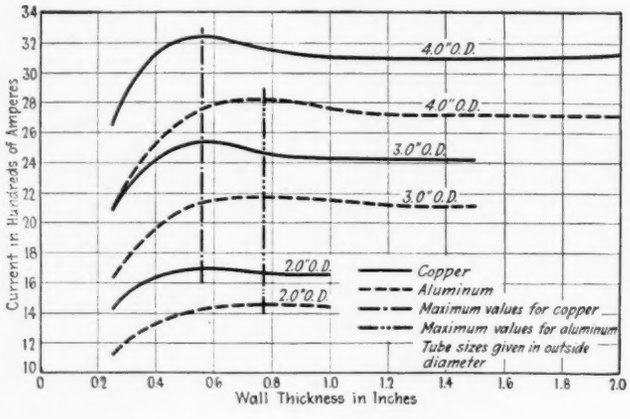
All splices and angles are made by using an internally bolted splice plate, Fig. 8. The channels are mitered, in the case of an angle, to fit together property and to present a neat appearance. The internal splice plate, of whatever shape required and having a

TABLE I—PIPE-SIZE TUBULAR-CONDUCTOR CAPACITIES FOR 30 DEG. C. RISE AT 60 CYCLES BASED ON 30 DEG. AMBIENT

| Pipe Size, In. | Pipe O.D. In. | Metal Area Sq.In. | Copper, Weight per Ft., Lb. | Copper, Amp. | Aluminum, Weight per Ft., Lb. | Aluminum, Amp. |
|---|---|---|---|---|---|---|
| ¼ | 0.840 | 0.250 | 0.965 | 450 | 0.292 | 350 |
| ⅜ | 1.050 | 0.331 | 1.278 | 570 | 0.399 | 440 |
| 1 | 1.315 | 0.494 | 1.906 | 740 | 0.578 | 570 |
| 1¼ | 1.660 | 0.675 | 2.605 | 940 | 0.790 | 730 |
| 1½ | 1.900 | 0.80 | 3.085 | 1,075 | 0.936 | 830 |
| 2 | 2.375 | 1.08 | 4.170 | 1,360 | 1,263 | 1,060 |
| 2½ | 2.875 | 1.71 | 6.600 | 1,840 | 2.000 | 1,430 |
| 3 | 3.500 | 2.21 | 8.530 | 2,230 | 2.580 | 1,730 |
| 3½ | 4.000 | 2.68 | 10.350 | 2,540 | 3.140 | 1,980 |
| 4 | 4.500 | 3.18 | 12.280 | 2,880 | 3.720 | 2,230 |

TABLE II—RATINGS FOR PAIRS OF ALUMINUM CHANNEL CONDUCTORS ARRANGED TO FORM A SQUARE, TEMPERATURE RISE 30 DEG. C. ABOVE 40 DEG. AMBIENT, AT 60 CYCLES

| Channel Size, In. | Web Thickness, In. | Flange Width, In. | Lb. per Ft. (2 Channels) | Cross Section, Sq.In. (2 Channels) | Effective Current Density Amp. per Sq.In. | Rated Amp |
|---|---|---|---|---|---|---|
| 4 | 0.180 | 1.580 | 3.80 | 3.14 | 796 | 2,500 |
| 4 | 0.247 | 1.647 | 4.44 | 3.68 | 762 | 2,800 |
| 5 | 0.325 | 1.885 | 6.40 | 5.28 | 683 | 3,600 |
| 6 | 0.437 | 2.157 | 9.26 | 7.64 | 615 | 4,700 |
| 7 | 0.524 | 0.404 | 12.26 | 10.14 | 563 | 5,800 |
| 8 | 0.579 | 2.619 | 15.12 | 12.50 | 536 | 6,700 |



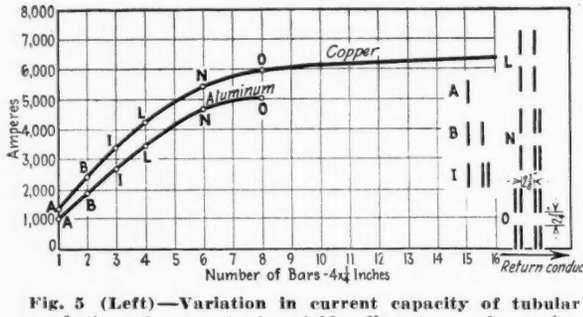




**Fig. 5 (Left)—Variation in current capacity of tubular conductors for constant outside diameter and varying wall thickness**

**Fig. 6 (Above)—Current capacity of 4x¼-in. bar conductors arranged as shown for 35 deg. c., hot-spot rise. Return conductor spaced 18 in. or over**

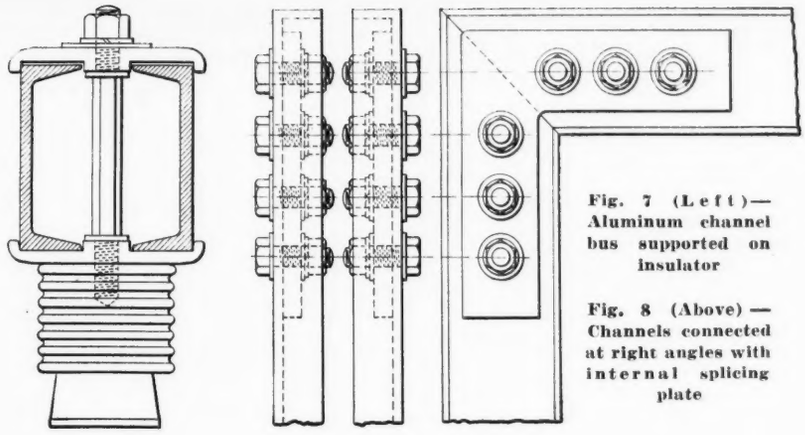


**Fig. 7 (Left)—Aluminum channel bus supported on insulator**

**Fig. 8 (Above)—Channels connected at right angles with internal splicing plate**

section approximately equal to the channel, is inserted internally and bolted, as in Figs. 2 and 8. No difficulty is experienced in the field in connecting splices and angles, as ample space is provided between the channels to permit the nuts to be held in position.

In general, taps to the channel type of bus are made with flat bar suitable for connecting to the terminals of the equipment. These bars are bolted to the channel.

Fig. 4 shows the end view of a 6,000-amp., 440-volt, 60-cycle bus used for supplying the electric heating load in a new aluminum plate mill in Alcoa, Tenn. Two circuits were used to reduce the reactance. For this low-voltage work a somewhat different type of support is used. Insulated pipe supports hold the channel clamps, and the details of the support are such as will permit of longitudinal expansion of the channels.

Except in extremely long runs, no expansion joints will be necessary, but if desired one set of supports near the middle of a bus may be clamped rigidly to the channels, permitting expansion in both directions.

The Chute-a-Caron power house, on the Saguenay River, Province of Quebec, will contain four 56,250-kva., 13,200-volt, 60-cycle generators, two of which are in service at present. Channels are used for the main bus connecting the generator, oil circuit breaker and transformers.

Fig. 2 indicates the junction of the channels used for low-tension transformer delta and the main lead from the oil switch. Ordinary porcelain tubes are used through the wall.

▼ ▼ ▼

# Quality Corrections In Engine Performance

PARAGRAPH 43 of the present A.S.M.E. Test Code for Reciprocating Engines reads, in part, as follows:

"In view of the fact that 'dry steam' is practically unobtainable commercially and that the presence of moisture is detrimental to the economy of an engine to a greater degree than the amount present in the steam would indicate, appropriate corrections for correcting the actual steam rate for quality are to be used in arriving at a value of 'corrected steam.'"

In other words, the correction for moisture must be some greater figure than the per cent of moisture present in the entering steam to determine the probable performance of the engine were it supplied with 100 per cent dry steam.

It has been established by various tests here and abroad that the steam turbine suffers detriment through the presence of water as droplets in the steam. This is due, as the late Professor Goodenough and others have shown, to differences in relative velocities of steam and water droplets in mixtures of the two, and to incorrect entrance angles to the blades of the relative velocities of the water drops. It has generally been found that the stage efficiency of a turbine is decreased from the performance of that stage with dry steam about 1 per cent for each per cent of moisture present at a given stage.

Back in 1893 the late Prof. R. C. Carpenter and Prof. L. S. Marks presented a paper before A.S.M.E. entitled "Experimental Determination of the Effect of Water in Steam on the Economy of the Steam Engine." This paper showed definitely that, in the case of the engine tested, the pounds of dry steam per horsepower per hour remained substantially constant for wide variations in quality of entering steam. The authors concluded that, for the class of engine under consideration, the heat carried by the entrained water performs no useful function and that a fair measure of economy of an engine is the consumption of dry and saturated steam under any quality of steam supply.

The calculation of the net dry steam per horsepower-hour is readily computed on a test when the initial quality is known. The nature of the additional quality corrections called for by the code is not widely known by engineers, although these may have been established by tests in builders' shops and elsewhere. It is highly desirable that information on these quality corrections be widely disseminated among the profession.

## Utilization of Salvaged Apparatus

THE PROPER utilization of salvaged apparatus requires coordinated study and cooperation on the part of members of the operating and engineering departments. The age of the equipment, its possible life if installed, the cost of any changes it may be necessary to make to it or to other equipment or to plans, if it is to be used, as against the depreciation write-off, if it is junked, are the main factors which must be considered. Another important factor, sometimes overlooked, is the cost of maintaining it, as against the maintenance cost for new equipment. It will sometimes be found that spare parts are either difficult to secure or relatively expensive. The operator must be willing to bury his natural disinclination to install second-hand equipment, and the engineer must be willing sometimes to disarrange a nice looking plan, if salvaged equipment is to be economically used.

On the other hand, care must be taken that a large stock of salvage material which will never be used is not allowed to accumulate. One company has a materials committee composed of representatives from various departments. Slow moving and salvage material is brought to the attention of this committee and some member usually volunteers to see that it is disposed of; he is then held responsible for this being done. If no one knows of any use for a piece of apparatus, it is junked. A man known as the material engineer keeps in touch with all apparatus in stock. Before any new job is started, the designers send out a list of major material, which is checked with that on hand. The materials committee has the authority to enforce the use of salvage material, unless the intended user can show very good reason why its use would be impractical. The office of the chief engineer approves and enforces the use of large pieces of salvage equipment.—*From report of subcommittee on Operating and Maintenance Methods, Pacific Coast Electrical Association.*

▼

SALES of coal pulverizers in June, as reported to the Bureau of the Census, totaled 21 having a capacity of 66,160 lb., compared with 4 in May with a capacity of 4,300 lb.

# From Among Readers' Problems

*Conducted by*
L. H. MORRISON

ESTIMATING WEIGHT OF COAL IN STORAGE PILE — *How can an estimate be made of the number of tons of coal in a storage pile?* L.C.G.

Storage piles of commercial sizes on anthracite vary in weight from 58 lb., per cubic foot in the larger sizes to 54 lb. per cubic foot of buckwheat. Piles of free-burning bituminous coals weigh about 56 lb. per cubic foot, and storage piles of the lighter Midwest coal about 49 lb. per cubic foot.

The weight of a given bulk of coal depends largely on the quantity of surface moisture, the proportion of coarse and fine sizes, and the amount of shaking or settling as the coal is delivered or stored. As ordinarily handled and piled it is customary to allow about 36 cu.ft. of bulk per ton (2,000 lb.) of anthracite and 40 cu.ft. per ton of bituminous.

—❖—

CLEARANCE OF CORLISS VALVES — *In reboring the valve seats of a corliss engine and fitting new valves, what radial clearance should be allowed?* M.C.

It is general practice to allow a radial clearance of about 0.002 in. between the valve face and its seat. But the amount of clearance allowed for in machining cannot be relied upon as a final fit, since the valve warps somewhat in use. The proper procedure is to make the allowance mentioned in turning and boring and after a short period of operation remove the valves and scrape down the high spots shown by wear.

—❖—

LOCATION OF GAS SAMPLING TUBE— *Where should gas samples be obtained for determining the percent of $CO_2$ in boiler flue-gas analyses?* J.C.K.

It is often desirable to determine the percentage of $CO_2$ in the gases in different passes of the boiler, but the final composition is of the most importance, and the sample is taken, usually, from the breeching or uptake between the boiler proper and the stack, preferably at a point where the gases are just leaving the boiler. If the position of the sampling tube is to be fixed the location of the open end should be such that the samples used are as nearly as possible representative of the whole volume of gas discharged.

To determine the best position, tests should be made with the open end of the tube placed at different points of cross-section of the gas passage, and the position giving most nearly average results should be selected for the fixed position. Another method is to make use of a main sampling tube, with branches in the gas passage extended to different points. Then the results should be checked occasionally by comparison with the average results obtained by separate tests of samples taken from different parts of the cross-section of the gas passage.

CLEANING SCALE FROM CYLINDER JACKETS OF DIESEL ENGINE — *What chemical may be used for cleaning the scale out of diesel engine cylinder heads and jackets?* H.C.R.

MURIATIC acid is the chemical most frequently used. Pour mixture of 25 per cent strength—one gallon of acid and three gallons of water—into the jacket and allow it to remain about three hours, or longer if the scale is very hard, until fuming of the chemical ceases. Allow the mixture to run out and then flush the jackets with water. Although there is little danger of the acid's affecting the iron, it should not be allowed to remain in the jackets any longer than necessary to soften the scale.

## PREVIOUS QUESTION DISCUSSED BY READERS

### THE QUESTION

*THE BOILERS in our plant operate at an average pressure of 430 lb., and the feed line pressure runs around 500 lb. When coming up with load in the morning the automatic feed-water valves tend to close off suddenly owing to the rising water level in the boiler. When these valves close, the feed line pressure between them and the check valve at feed pump rises to 700 to 750 lb. pressure. I should like to know the cause for this high pressure and what can be done to obviate it.* H.R.L.

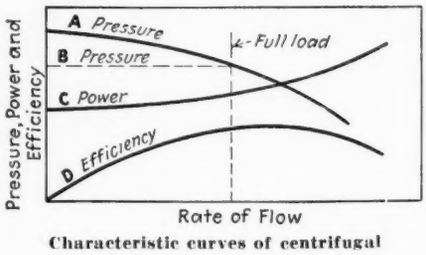
CLOSING OFF of the automatic feed-water controllers as a result of rising water level is caused by an increase in steam load, the latter momentarily causing the steam pressure to drop and allowing the water to "swell."

The pump pressure-flow characteristic mentioned indicates the use of a centrifugal pump driven either by a turbine or motor, most likely the latter, and at constant speed. This characteristic is natural of all centrifugal pumps driven at constant speed.

The centrifugal pump characteristic curves *A*, *C* and *D*, shown in the accompanying illustration, are typical of all centrifugal pumps driven at constant speed, or practically so. The ideal pressure-flow curve would be one practically flat, such as curve *B*, instead of dropping off as the flow increased. If the pump in question has characteristic curves similar to those shown when driven at constant speed, and the rising pressure with decreasing flow must be corrected, there are several means possible. It must first be remembered that the developed head or pressure varies as the square of the velocity. Realizing this fact, several possibilities suggest themselves, as follows:

1. If the pump is to be driven by a turbine the steam to the turbine can be throttled by a governor in the steam line supplying the turbine and actuated by the boiler feed pressure so as to maintain a constant feed-pump discharge pressure.

2. If the pump is to be motor-driven several means are possible, such as, (*a*) using a variable-speed slip ring motor or brush-shifting motor and having the rotor current in the former and the brush position in the latter controlled automatically to establish a speed that will maintain a constant discharge pressure; and (*b*) the Rossman drive, using a constant-speed induction motor large enough to develop the desired




**Characteristic curves of centrifugal pump operating at constant speed**

pressure against dead end at no flow and having this motor so mounted that the entire motor may be rotated. A smaller motor of the variable-speed slip-ring type or a brush-shifting type would be mechanically connected to the large constant-speed motor to revolve it. The small motor speed would be governed automatically by the pump discharge pressure.

As previously mentioned, the head varies as the square of the velocity, and a slight change in velocity or pump speed will make a disproportionately greater change in developed head. Therefore unless well designed apparatus is used, hunting will result.

It will be noted that with each of the foregoing methods the feed pump is not allowed to churn against restricted flow, which might result in steam-binding the pump or "freezing" of the impeller rings if allowed to overheat.

If the periods of restricted flow are few and of short duration and the head or pressure at the pump suction high enough, a relief valve or "unloading" valve can be placed in the pump discharge line and the valve spring- or weight-loaded of such setting that it will open up and bypass enough discharged water back into the pump suction to maintain constant pressure beyond the unloading valve.

All of these methods, if properly conditioned, will serve the purpose. The choice will be governed by the engineering economics of each case, as affected by fixed charges, operating charges and dependability. Of course, the latter method is the most simple and probably most applicable to the case considered.

All of the above methods will result in a pressure-flow curve similar to curve *B*, which, it is readily seen, should be flat for all rates of flow from no flow up to the maximum for which the pump was designed.

San Francisco, Calif. HUGH J. BYRNE.

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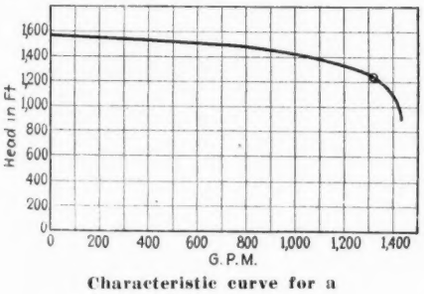
THE ACCOMPANYING ILLUSTRATION shows an actual characteristic curve for a 1,260-g.p.m. centrifugal pump. Head pressure is plotted against pumping capacity. This curve is typical for all standard centrifugal pumps. Conditions at rated capacity are indicated by the circle.

Now, as the amount of water pumped is decreased, the head pressure increases, and vice versa, the magnitude of the change depending upon the position of the initial conditions on the curve. For instance, if the pump is operating at 1,260 g.p.m. and suddenly drops to zero by closing of the discharge valve, the discharge pressure will rise from 1,240 to 1,560 ft., an increase of 320 ft. of water. Thus an increase of 320 ft., or 139 lb. per square inch pressure, was brought about by a decrease of 1,260 gallons per minute.




**Characteristic curve for a 1,260-g.p.m. pump**

If the pump is operating at 1,460 g.p.m. and suddenly drops to 1,260 g.p.m. as a result of the partial closing of a valve, the discharge pressure will rise from 920 to 1,240 ft., an increase of 320 ft. of water. Thus, an increase of 320 ft., or 139 lb. per square inch pressure, was brought about by a decrease of 200 g.p.m. If the pump had been operating at 1,460 g.p.m. and suddenly dropped to zero, the pressure would have gone to 1,560 ft. of water, or an increase of 278 lb. per square inch.

It is easily seen that under one condition of initial pumping conditions a decrease of 1,260 g.p.m. brought about an increase of 139 lb. per square inch pressure, while under a little heavier initial condition a decrease of only 200 g.p.m. produced a like increase in pressure.

As the curve shows, as soon as a centrifugal pump goes beyond its rated capacity, the capacity-head curve becomes much steeper, and a slight loss in capacity calls for an abnormal increase in head.

If the author of the question will install a pump of slightly greater capacity he will find that his operating conditions move along the more nearly flat portion of the curve and his troubles will probably be over. R. F. SORRELLS.

Beaumont, Texas.

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SINCE IT IS STATED that the high-pressure exists between the check valve and the boilers, and no mention is made of high pressure on the pump discharge, it must be assumed that the pressure rise is not caused by the pump. It must therefore be due solely to the momentum of the line-full of moving feed water.

The formula for the kinetic energy of any moving body is: $E = \frac{1}{2}Mv^2$, in which $M$ is the mass of the body, $v$ its velocity in feet per second, and $E$ its kinetic energy in foot pounds. From this it will be seen that the kinetic energy of the line-full of moving water will be proportional to its mass and to the square of its velocity. The mass of water involved will depend upon the length and the diameter of the feed line, and its velocity will depend upon the line diameter and the rate at which water is being supplied to the boilers.

Other things being equal, a long line would aggravate the trouble, as it would carry a greater mass of water. Also, a line of small diameter would cause a greater pressure rise, for the velocity will be inversely proportional to the square of the inside diameter and the kinetic energy increases as the square of the velocity.

One successful and fairly cheap solution of the difficulty would be to place a water pressure relief valve in the feed line near the boiler farthest from the feed pump. The relieved water could be piped back to the feed-water heater or to a surge tank connected to the feed-water system so that no great wastage of water would result.

The trouble could be remedied, to a certain extent by a more gradual use of steam for starting up the plant. It is the sudden and abnormal demand for steam that causes the extreme rise in level of the boiler water and the consequent closing of the feed valves.

Beaumont, Texas. M. F. KNOY.

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To overcome a similar trouble at our plant we first installed a bypass, or recirculator, from the auxiliary feed line to the pump suction. This bypass consisted of 1¼-in. line with a high-pressure globe valve to control the flow through it. This overcame the trouble satisfactorily, but the work of adjusting the valve to hold the pressure within certain limits in addition to the other duties proved to be a considerable burden to the fireman. The globe valve was later replaced by an excess-pressure regulating valve which operates automatically and prevents the pressure from going above a certain predetermined value.

Our reason for connecting the bypass to the auxiliary feed line is that the temperature is approximately the same as the feed pump suction.

CHARLES R. CUZNER.

Glace Bay, N. S.

## A Question for Our Readers

*UPON reclaiming a surface condenser not used for several years but which formerly operated under a heavy overload we find that the tubes are coated on the circulating-water side with about a ⅛-in. layer of hard scale. What is a practical method of removing this scale? Can it be satisfactorily dissolved with an acid, and if so how should it be done?* A.M.D.

Suitable answers from readers will be paid for[1] and published in the Sept. 8 number

[1]As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired):

Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkeisen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehling's *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Power Plant Lubrication;* Moyer and Fritz's *Refrigeration;* Rietschel-Brabbee's *Heating and Ventilation;* Annett's *Electric Elevators.*

# THE ENGINEER'S

## Steam Turbine Operation

STEAM TURBINE OPERATION. *By W. J. Kearton, lecturer in engineering, at the University of Liverpool, England. Published by Isaac Pitman & Sons, London, England; Toronto, Canada; and 2 West 45th St., New York City; 1931. Cloth, 5½x8½; 300 pages; illustrations, charts and diagrams. Price, $3.75.*

THE AUTHOR wisely recognized that there are available sufficient texts dealing with the thermodynamics and design of steam turbines, and that no book had been written that was of any great aid to the turbine operator. Thus in presenting to power engineers this book on steam turbine operation Mr. Kearton has filled a long-felt need. Even though the turbine types and operating methods are almost entirely English, the American operator will nevertheless find much of value to him in the book.

Though strictly an operating text, the author has included some design data in order to more clearly indicate and explain the various methods of operation. This applies particularly to the chapters on heating and drainage of turbines, turbine glands and gland sealing, governors and governing.

The introductory chapter deals with the installation of turbines and with the principles involved in shaft alignment. Subsequent chapters cover the subjects of lubrication, starting and stopping, inspection and overhauling, and turbine troubles. The two final chapters deal with turbine testing and with the special case of the Ljungstrom turbine.

## Utilization of Coal

MODERN COMBUSTION, COAL ECONOMICS AND FUEL FALLACIES. *By Clarence V. Beck. Published by the Mid-West Coal Retailer, 20 West Jackson Blvd., Chicago, Ill.; 1931. Leatherette, 382 pages; illustrations, charts and tables. Price, $3.*

"IMPROVEMENT in the coal industry is coming and must come from a modernization of production methods and a modernization of utilization—particularly the latter."

In these few words, Mr. Beck crystallizes his point of view and explains the purpose of his book. Convinced that the future growth of the coal industry is assured, he endeavors to show how this growth may be stimulated by the proper application of machinery to mines and the use of modern fuel-burning equipment in homes, public buildings, factories and central stations.

The book is divided into three parts covering coal economics, fuel fallacies and combustion. In the first part the author discusses the early organization of the mining industry, its labor problems, the introduction of mechanical mining and the difficulties of over capacity. He then takes up the purchasing policies of large coal users, the impetus afforded by the introduction of small stokers, the competitive fuel situation and trends within the industry.

Part II, entitled "Fuel Fallacies," is devoted to an analysis of the relative importance and economics of fuel oil and natural gas, together with a discussion of smoke abatment, coke, central station power and heat and water power.

By far the most extensive section of the book is Part III on modern combustion practice. Written especially for the coal industry, this part sets forth in simple terms the theory of combustion, design, operation and application of the various types of equipment, and the economics of heat and power generation. Furnaces, boilers, instruments and fuel-burning equipment are discussed, together with such topics as by-product heating or process steam, the modern small steam plant, smoke reduction, and present heating ills and their cause. The comparative fuel values of coal, oil and gas are given extensive treatment, along with many helpful suggestions on how the coal industry can meet the competition of other fuels.

## Power—The Yardstick

AMERICA'S ANSWER TO THE RUSSIAN CHALLENGE. *By Robert Sibley, executive manager of the California Alumni Association. Published by The Farallon Press, 58 Sutter St., San Francisco, Calif.; 1931. Cloth, 171 pages, illustrated; 5 appendices. Price, $5.*

TAKING Lenin's statement that "Communism is Sovietism plus electrification," Mr. Sibley makes electric power development his "yardstick" for measuring the accomplishments of Soviet Russia and comparing them with the achievements of Americanism, which, he says, is individualism plus electrification. On this basis, therefore, America's answer to the Russian challenge for industrial supremacy is superior electrification and the genius of individual initiative back of it.

For at the end of the Five Year Plan in 1933, according to the author, total generation of electrical energy in Russia will be 26,000 millions of kilowatt-hours, while in America production will have reached 134,000 millions of kilowatt-hours by that time.

"Again in the size of units of power development, one hears on all sides in Russia that when the Dnieprostroy is completed Russia will have the largest single hydro-electric generating station in the world," he writes. "While this is true, it is interesting to note that one single river in the United States, the San Joaquin in California, has upon it, already developed, a series of power plants totaling almost a million horsepower installed capacity. . . . And when other rivers of even this one state are taken into account, the total power of district units and the per capita consumption of electricity so far outranks any accomplishment of the Five Year Plan as to make Russia's great enterprise sink into insignificance in comparison."

Russia, in her intense craving for American industrial methods, in her insatiable ambition to measure up to and surpass America in her achievements, has appealed to the very best America has produced to guide her, Mr. Sibley points out. Hence, he believes, Soviet Russia will awaken some day, if she attains her industrial goal, with a complete incorporation of American methods. The efficient use of the type of American leadership and working tools Soviet Russia is adopting calls for that peculiar flair for adaptation that has made America what she is today in the matter of industrial supremacy. This peculiar American flair involves not only the mastery of principles of scientific management in mass assembling, standardized products, and the thousands of other mechanical details, but the full play of that type of individual initiative so forcefully demonstrated in all American efforts. This efficient use of the working tool, Mr. Sibley maintains, can take place only where this same American principle is invoked, otherwise the effort must fall far short of the mark of attainment.

## The Pulverized-Coal Engine

THE IGNITION AND COMBUSTION PROCESS IN THE PULVERIZED-COAL ENGINE. *By Dr. Wolfram Wentzel. Published as Forschungsheft 343 by the V.D.I-Verlag, Dorotheenstrasse 40, Berlin NW7, Germany; 1931. Paper, 8x12 in.; 24 pages, 21 illustrations, 9 tables. Price, RM 5.*

ENERGY produced in pulverized-coal internal-combustion engines is about 2.5 times as cheap as that generated in oil engines. For this reason, the further development of the pulverized-coal motor is of the greatest economic interest. In this development, however, an exact knowledge of the ignition and combustion processes in their relation to the kind and grain size of the coal used, excess air, pressure and temperature in the combustion chamber, etc., is an in-

# BOOKSHELF

dispensable prerequisite. These factors are dealt with in the present work, which is written in German.

After a description of his testing equipment, the author deals with the tests carried out to determine the igniting and burning times of pulverized coal blown by air pressure into compressed and heated air. The tests showed the lag in ignition to be independent to the amount of excess air, and almost independent of the injection pressure, but dependent upon the density of the air of combustion. Of decisive influence upon the lag in ignition was the smallest size of grain in the coal. With suitable powder, the ignition lag is from 0.01 to 0.03 seconds.

Time of combustion proved to be independent of the density of the air of combustion and its temperature, so long as the latter did not approach too closely to the ingition point. On the other hand, there was a marked influence exerted by the excess air and the injection pressure. In addition, the time of combustion was greatly affected by difference in the grain-size composition of the coal, and was less for coal rich in gas than for coal of low gas content. For suitable grades of powder, the combustion time varies between 0.15 and 0.35 sec. with sufficient excess aid and good injection.

## I.E.C. Turbine Rules

STEAM TURBINES: PART I, SPECIFICATION; PART II, RULES FOR ACCEPTANCE TESTS. *Publications 45 and 46 of the International Electrotechnical Commission (United States headquarters), 33 West 39th St.; New York City; 1931. Paper, 8x11 in. Part I, 16 pages; price, 50c. Part II, 50 pages; price, $1.*

FOR THE FIRST TIME in the history of steam engineering a set of rules and regulations for acceptance tests of steam turbines has been developed and approved for use in international commerce by 28 commercial nations.

This group of nations functioning through their national committees of the International Electrotechnical Commission under the guidance of Advisory Committee No. 5 on Steam Turbines have given their best talent in the preparation of this code or set of rules and regulations. The United States National Committee of the I.E.C. was assigned the duties of Secretariat for Advisory Committee No. 5 on Steam Turbines. The American Society of Mechanical Engineers through the activity of its Main Committee on Power Test Codes has contributed a considerable amount of the foundation material.

In the final printed form the regulations are divided into two parts. Dealing with specifications, Part I covers information to be supplied with inquiry or order for steam turbines; suggested standard ratings; suggested standard steam pressures; and graphical symbols for heat-power systems. Part II contains rules for acceptance tests and covers the object and scope of such tests; terms and symbols for heat and thermodynamics; guiding principles; mandatory rules for instruments and methods of measurement; computation of results; and the approved style for reports of acceptance tests.

## Power Line Mechanics

SAGS AND TENSIONS IN OVERHEAD LINES. *By C. G. Watson. Published by Isaac Pitman & Sons, London, England; Toronto, Canada; and 2 West 45th St., New York City; 1931. Cloth, 5½x8½ in.; 192 pages, 81 illustrations. Price, $3.75.*

PROBLEMS dealing with sag and tension in overhead power lines are usually solved by involved mathematics. In this book the author has reduced the work to plotting and reading a graph and the operations of simple arithmetic. The treatment has been very largely developed around practical problems, so that the reader should have little difficulty in applying the principle involved.

The important chapters are: The Thomas chart; supports at different levels; cables not previously stretched; stringing charts; behavior of lines after erection; a river crossing; and the parabola. There are also four appendices, covering hyperbolic functions, catenarian functions, supports at different levels and tables of tangent. Among those interested in power-line problems this book should find a wide field of usefulness.

# BRIEF REVIEWS

A STUDY OF REFRACTORIES SERVICE CONDITIONS IN BOILER FURNACES. By Ralph A. Sherman, United States Bureau of Mines. Bulletin No. 334, for sale by the Superintendent of Documents, Washington, D. C.; 144 pages, illustrated; price 50c.—Presents, correlates and compares the significant data of a field investigation which the Bureau of Mines has conducted over the past five years for the A.S.M.E. Special Research Committee.

THE SIGNIFICANCE OF SOLVENT ANALYSIS AS APPLIED TO COAL. By E. B. Kester. Published as Circular 6486 by the United States Bureau of Mines, Washington, D. C.; 17 pages.—Describes the use of solvents in determining more accurately the constituents of coal.

STANDARDS OF THE HYDRAULIC SOCIETY. Compiled and published by The Hydraulic Society, 90 West St., New York City; 96 pages, illustrated; price $1.—Standard terms, tests and practices recommended for all pumps.

AMERICAN INDUSTRIAL PROPERTY. By Joseph J. Juhass and Alexander Mencher. Published by Juhass & Mencher, 342 Madison Ave., New York City; 58 pages. A comprehensive summary of the law of patents, trade marks and copyrights for engineers and business men.

Recent publications of the V.D.I.-Verlag, Dorothenstrasse 40, Berlin NW7, Germany, include the following: THERMODYNAMISCHE RECHNUNGSGRUNDLAGEN DER VERBRENNUNGSKRAFTMASCHINEN UND IHRE ANWENDUGN AUF DEN HÖHENFLUGMOTOR, by Asmus Hansen; 28 pages, 22 tables; price RM 5. DAS MITREISSEN VON WASSER AUS DEM DAMPFKESSEL, by Heinrich Vorkauf; 22 pages, illustrated; price RM 5. UNTERSUCHUNGEN AN DER DIESEILMASCHINE—DER SPUL — UND LADEVORGANG BEI ZWEITAKTMASCHINEN, by Kurt Neumann, and DAS ARBEITSVERFAHREN RASCHLAUFENDER ZWEITAKT-VERGASERMASCHINEN, by Otto Klüsener; 46 pages, illustrated; price RM 8.50. VOLLSTANDIGE ZAHLENTAFEL UND DIAGRAMME FÜR DAS SPEZIFISCHE VOLUMEN DES WASSERDAMPFES BEI DRÜCKEN ZWISCHEN 1 UND 270 AT., by H. Speyerer and G. Sauer; 7 pages; price RM 2.50. MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN DES GHH-KONZERNS; 32 pages; price RM4.50.

HANDBOOK OF STEAM FLOW MEASUREMENT. By L. K. Spink. Published by the Foxboro Company, Foxboro, Mass.; paper, 47 pages, illustrated.—A brief, comprehensive treatise on the measurement and calculation of steam flow under various conditions.

AMERICAN STANDARDS YEAR BOOK, 1931. Published by the American Standards Association, 29 West 39th St., New York City; paper, 102 pages.—In addition to reviewing the activities of the A.S.A. during the past year, this book describes developments in international standardization and the cooperative activities of trade associations, technical societies and government departments in standardization work in this country.

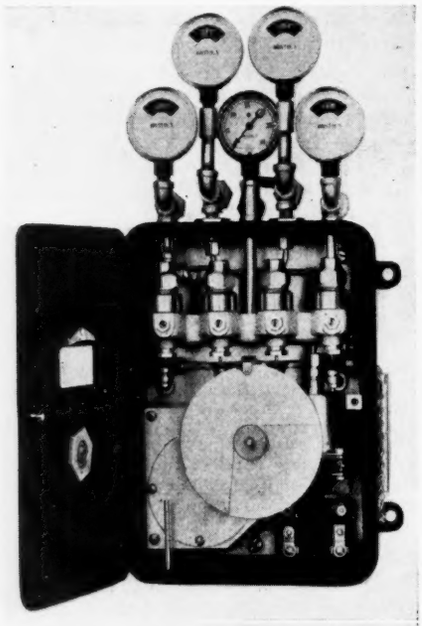
# WHAT'S NEW IN PLANT EQUIPMENT

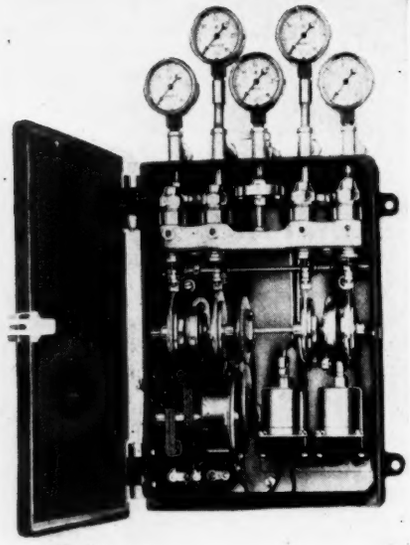
## Pneumatic Cycle Controllers

IN A LARGE PROPORTION of controlled processes the conditions are such that the operations may be controlled by a single-cam instrument in which a number of pilot valves are actuated, in turn, by a motor-driven cam. This cam may be made adjustable within certain limits; and speeds are determined by change-gearing between the synchronous motor and the camshaft. Starting and stopping of the motor are usually governed by a pressure-operated switch within the case of the instrument. A single-cam controller is shown in the upper view.

Where greater flexibility is required, and the different events in the cycle overlap by varying degrees, rendering control by a single cam impracticable, the type of instrument shown in the lower view has been made available. Here several individual cams are mounted on a common shaft, and each is adjustable through a wide range, both as regards the duration of its influence in the cycle and its position in the sequence of events. The pneumatic features of this instrument are identical with those of the single-cam controller. Two pressure switches may be furnished where desired.

The instruments described do not perform the function of regulation; but they may be used in conjunction with pneumatic or electrical regulating devices for pressure, temperature, etc.; and, with suitable accessory equipment, they lend themselves to those types of control where a certain degree of interlocking is required. Both types of controllers are manufactured by the Bristol Company, Waterbury, Conn.





**Single- and multiple-cam controllers**

## New Packing in Coil Form

A NEW PACKING IN COIL FORM is announced by Metalastic, Inc., Union City, N. J. The base of the new packing is a metal which is said to resist corrosion from acids, alkalies, and electrolysis and to withstand temperature in excess of 1,200 deg. F. It is also said to possess the desirable property of expansion upon cooling. This metal is present in the form of a powder which thoroughly coats the fibrous asbestos particles with a metallic covering, and presents a metal-to-metal contact. These metal-covered fibers are thoroughly lubricated and bonded together under pressure, forming a homogeneous packing. Some of the services on which the packing can be used are hot and cold water; superheated steam; air and other gases; oil, sulphuric and other acids; ammonia, brine, and carbon dioxide.

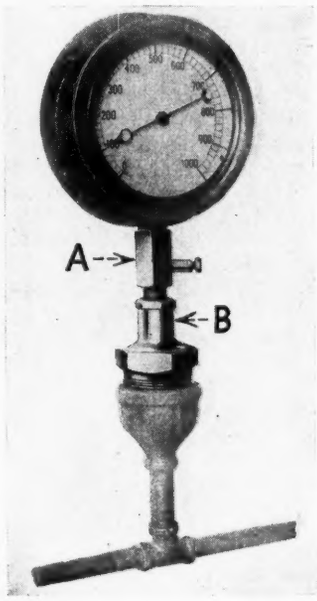
The new packing is available in fourteen sizes from $\frac{3}{16}$ in. to 1 in., inclusive.

## Gage Protector and Non-Pulsator

TO ELIMINATE the wear on pressure gages from pulsation and to safeguard the pressure elements of the gage against action from acid or other chemical on which the gage may be used the two fittings *A* and *B* shown in the illustration have been introduced by Champion & Barber, 576 Subway Terminal Bldg., Los Angeles, Calif.

Fitting *A*, termed a non-pulsator, is designed to remove all pulsation in the gage movement by restricting the fluid passage. The restriction is effected by means of a needle valve incorporated in the fitting.

The gage protector *B* is a bronze-bodied rubber-bulbed pressure-transmitting unit used to transmit line pressure to indicating gages by means of a secondary or bulb pressure. The rubber pressure bulb is so installed that the line pressure, either fluids, liquids or air, operates against its base. This pressure, in turn, compresses the glycerine-filled bulb, causing it to exert a corresponding pressure on the gage movement. The body of the protector is made of a special anti-corrosive bronze.

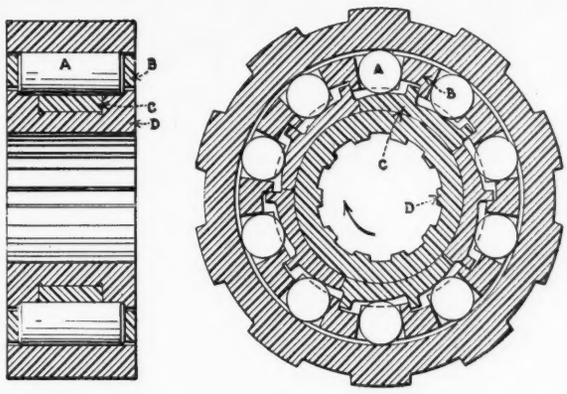



**Non-pulsator and protector in gage connection**

## Improved Roller Clutch Bearing

AN IMPROVED type of roller clutch bearing in which one set of rollers serves to effect a clutching action in one direction of rotation and to support the rotating member for free rotation in the opposite direction is illustrated. The bearing is adaptable to practically all types of equipment and is designed to take the place of the usual ratchet or backstop.

The principle upon which the com-



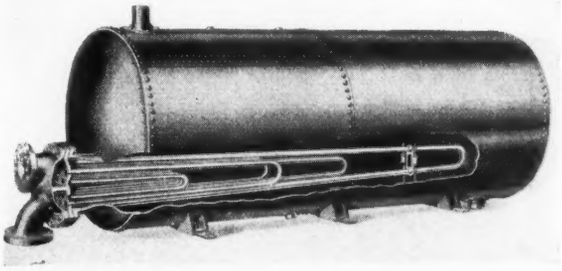

**Sectional views of Weiss roller clutch bearing, which takes the place of the usual ratchet or backstop**

bined clutch and bearing operate will be clearly understood from a study of the accompanying illustration. The rollers *A* are uniformly spaced by a ring *B* having lugs on its inner side which contact with lugs on the locking ring *C*. This locking ring is made up of a series of sections, one for each two rollers, and the outer, or roller bearing, surface is inclined to provide a clamping action on the rollers.

With the inner member *D* rotating in the direction indicated, the design shown operates as a standard roller or ball bearing; but when the rotation is reversed the rollers roll up on the inclined surfaces and bind between the inner and outer rings to effect a driving engagement between the two members. The clutch bearing is put out by the Weiss Engineering Company, Grand Central Terminal Bldg., New York City.

## Improved Submerged-Type Water-Heating Element

DISTRIBUTION of heating surface proportionally to length and storage capacity of tank is a feature of the new "Freflo"



**Cut-away view showing arrangement of heating elements**

heating element now being put out by the National Pipe Bending Company, Lloyd and River Sts., New Haven, Conn.

The heating element consists of a group of U-bends of copper tubing expanded in either a steel or a bronze tube plate. The distribution of the heating surface is effected by making each row of U-bends of an increasing diameter of tubing of varying lengths, from the smallest diameter and shortest length to the largest diameter and longest length. The entrance ends of the U-bends are spread to give a pitch or slope to the horizontal runs, this preventing air or water pockets from forming in the tubes. The outer row, with the largest diameter tubes, can be extended practically the entire length of the tank. The length of the successive rows is proportioned to their respective flow areas. The longest coil is flexibly supported near the outer end.

Sizes available range in capacity from 100 gal. per hour to 2,000 gal. per hour heated from 50 to 150 deg., with tank diameters ranging from 30 to 84 inches.

## Insulating Firebrick for Boiler and Industrial Furnaces

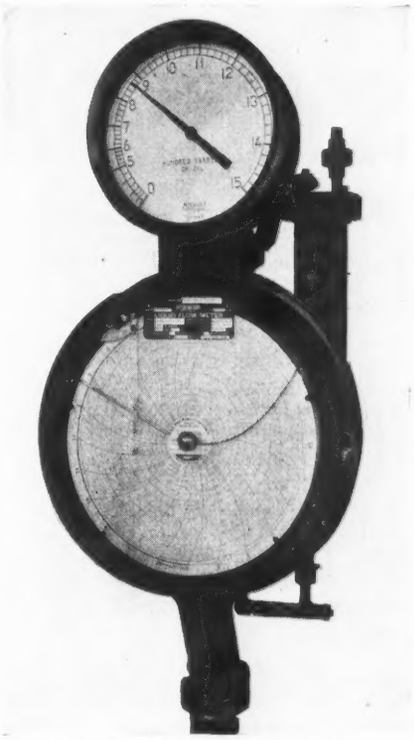
A NEW INSULATING firebrick known as the B. & W. No. 80 is announced by the Babcock & Wilcox Company, 85 Liberty St., New York City. Although this material has previously been made experimentally, no practical method of manufacturing it in brick sizes has been developed until recently.

The new brick is not only a good insulator, but is said to be the equal of a first-quality firebrick, and when used as linings for intermittent furnaces will result in considerable fuel savings during heating-up periods. It is further claimed that a furnace lined with this brick and designed to have the same heat flow through the walls as one lined with firebrick will have about one-sixteenth the heat-storage capacity.

The brick may be used without a facing of firebrick on the furnace side exposed to furnace temperatures and gases and protected only by a coating of high-temperature cement. It is suitable for lining oil- and gas-fired furnaces, electric furnaces of the resistance type and for coal-fired equipment wherever it may be used in protected wall areas not exposed to mechanical abrasion and slag action. The bricks may be cut, drilled or shaped with ordinary woodworking tools.

## Combination Flow Meter

DESIGNED for use on processes, the combined recording, integrating and indicating flow meter recently introduced by the Foxboro Company, Foxboro, Mass., has an 8-in. indicating scale mounted directly over the recorder case as shown in the illustration. The dial of the indicating instrument has a long, open, concentric scale, plain tapered

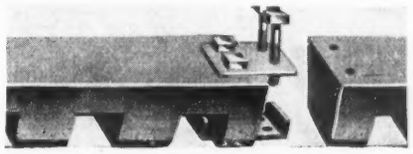


**Recording flow meter with 8-in. indicating scale**

pointer, and block numbers. In addition, the instrument can be supplied with a recording integrator which makes a record on the chart of the total flow.

## Link-Wedge Belt

MANUFACTURING AND DISTRIBUTING rights for the link-wedge V-belt recently developed in Germany have been acquired by the Dayton Rubber Manufacturing Company, Dayton, Ohio. The belt consists of rubber and fabric with



**Section of belt with clamps for ends**

integral cogs on the inside. It is adapted to run on a standard V-shaped pulley. The belts are made in large sheets and can be cut to the desired width and length. On this account it is said to be possible to make a belt of any necessary length at minimum cost. The illustration shows the metal clamp used to join the ends.

# NEWS of the FIELD

## Canadian Pacific's First 1,300-Lb. Locomotive Shows Large Fuel Savings on Heavy Trial Run

THE FIRST 1,300-lb. pressure locomotive in America was tested recently by the Canadian Pacific Railway, on a trial run between Smith's Falls, Ont., and Montreal. Designed by H. R. Bowen, chief of motive power and rolling stock for the Canadian Pacific, and constructed in the railway's shops at Montreal to haul a train weighing 6,000 tons, the engine, known as the "8,000" multi-pressure locomotive, actually pulled a load weighing 7,691 tons and covered 128.7 miles in 5 hr. 45 min. with a 30 per cent fuel economy over other freight engines. Equivalent to three normal trains on that division, the test train was more than a mile and a third long.

The "8,000," an oil-burning three-cylinder type, is said to represent a new era in steam motive power because it embodies a radical departure in boiler design and makes use of steam pressures considerably higher than any used heretofore in American locomotives. Steam is generated in three separate "boiler sections" at three different pressures. The firebox and combustion chamber are formed by one set of tubes, in which steam at 1,300 or 1,350 lb. per sq.in. is generated from distilled water sealed in the tubes. This steam circulates through the high-pressure drum where water is converted into steam at 850 lb. pressure. The 850-lb. steam passes through a superheater to the high-pressure cylinder of the engine. The low-pressure boiler, which resembles the barrel section of the conventional locomotive boiler, generates steam at 250 lb. pressure, which flows through a second superheater and joins the exhaust steam from the high-pressure cylinder to feed the two low-pressure cylinders located in the normal position.

The locomotive weighs 485,000 lb. and the tender 300,000 lb., a total of 392.5 tons, while the over-all length is 99 ft. 3.5 in. It has a tractive effort of 90,000 lb., approximately 17,000 lb. more than the largest locomotive previously made.

Mr. Bowen designed the "8,000" in cooperation with the American Locomotive Company and the Superheater Company, after he had made a special trip to Europe in 1929 to study various types of foreign locomotives. The American Locomotive Company is building a similar engine for the New York Central Railroad, which, it is reported, will be finished soon.

## Five 6,000-Kw. Diesel Units Purchased by Vernon, Calif.

THE CITY of Vernon, Calif., on July 17 awarded a contract for five diesel-engine electric generating units of 6,000 kw. capacity each to the Hooven, Owens, Rentschler Company of Hamilton, Ohio. The amount of the contract was $1,500,000, according to the Vernon City Clerk. First of the five units will be delivered to the city in eight months, and delivery of the remaining units will be made one each month.

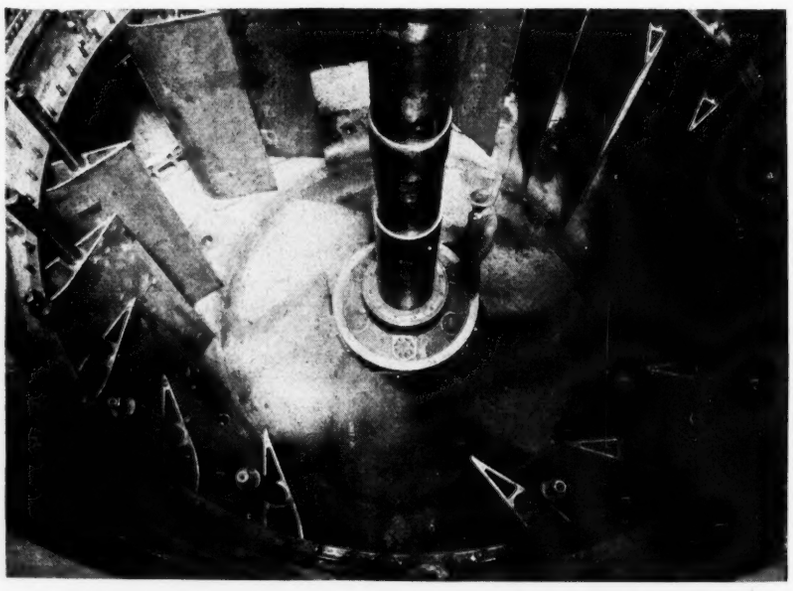
A bond issue for the construction of a municipal power plant was voted by Vernon citizens in Sept., 1930.

## U. S. Delegation Named for Paris Electrical Congress

ORGANIZATION was effected at a meeting last week of the United States National Committee of the International Electrotechnical Commission of a United States committee to participate in the Electrical Congress, which will be held at Paris, France, in 1932. E. W. Rice, honorary chairman of the General Electric Company, was named chairman of the committee, along with the following members: G. K. Burgess, James Burke, L. W. Chubb, W. D. Coolidge, E. C. Crittenden, W. A. Del Mar, Gano Dunn, L. L. Elden, L. A. Ferguson, A. N. Goldsmith, C. R. Harte, D. C. Jackson, F. B. Jewett, A. E. Kennelly, C. O. Mailloux, J. H. McGraw, R. A. Millikan, I. E. Moultrop, F. D. Newbury, H. S. Osborne, Farley Osgood, F. W. Peek, Harold Pender, M. I. Pupin, L. T. Robinson, L. B. Stillwell, N. W. Storer, S. W. Stratton, P. Torchio and W. R. Whitney.

The congress is being held to celebrate the 50th anniversary of the first Electrical Congress held at Paris in

## PROPELLER TURBINE FOR ROCK ISLAND



One of the large propeller type turbines being installed in the Rock Island plant of the Puget Sound Power & Light Company, on the Columbia River near Wenatchee, Wash. These turbines will operate under a variable head of 48 ft. maximum and 20 ft. minimum. The first four 15,000-kw. units of an ultimate of ten will soon go ntio service

1881, at which the fundamental electrical units were established on an international basis. It is being organized by the French National Committee of the I.E.C., and many of the important power and electrical organizations in France will take part in it. At first the date of the congress was set for 1931, which would be the actual 50th anniversary of the original meeting, but due to the fact that Great Britain is celebrating the Faraday Centenary this year, the French agreed to postpone the Electrical Congress until 1932.

## Stevens Institute to Aid Boys in Choosing Careers

TO GIVE BOYS a better understanding of engineering as a possible life work and to help them in determining their fitness for the profession, Stevens Institute of Technology will open its new engineering camp near Johnsonburg, N. J., from Aug. 15 to 29, to a selected group of secondary school students who have completed three years of preparatory work. The boys will be told by lectures, posters and movies what engineering in general is all about, and they will receive some experience in a simple kind of engineering through a few hours a day of field work in surveying.

Each boy at camp will be given Johnson O'Connor's individual aptitude tests, which help to indicate the boy's ability to do work of the engineering type. The group will be small enough so that every boy will receive individual help and advice as to the selection of a college—whether his chances of success would seem better in engineering or in some line requiring a liberal arts course. In addition, those attending are assured of a thoroughly good time in the open.

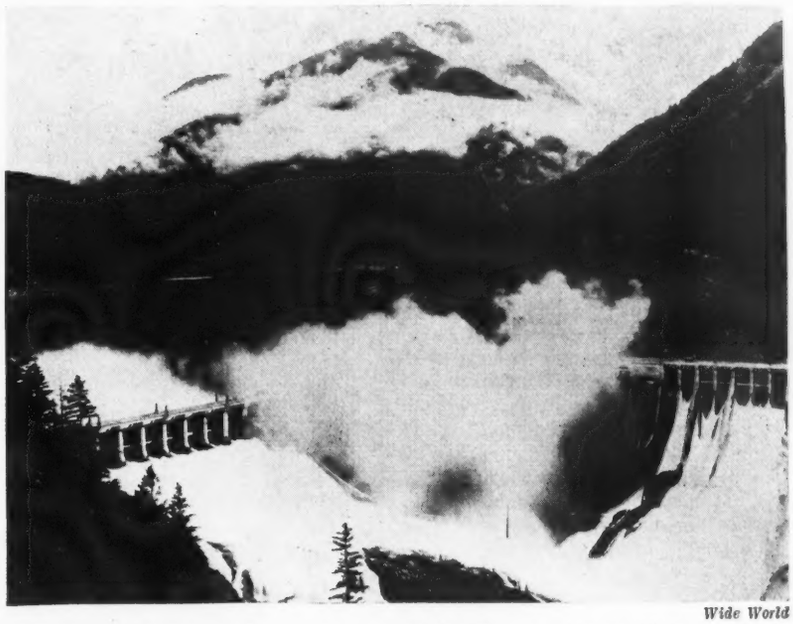
Applications for admission to the camp should be sent to the President's Office, Stevens Institute of Technology, Hoboken, N. J.

## Testing Materials Congress To Be Held in September

THE FIRST international congress of the new International Association for the Testing of Materials will be held this year from Sept. 6 to 12 in Zurich, Switzerland. This new association, consisting of individuals and companies in the various countries, was organized to secure international cooperation, exchange of views and experience on all matters pertaining to testing materials. Contacts in the United States have been established through the American Society for Testing Materials, many of whose members belong to the international body.

The technical program of the congress is divided into four groups, covering metals, non-metallic inorganic materials, organic materials and topics of general importance. Among the papers to be presented by Americans are: "Advances in Microsopy," F. F. Lucas; "Stress Corrosion of Metals," D. J. McAdam, Jr.; "Sampling Coal," W. A. Selvig; "Tests for Bituminous Materials," Prevost Hubbard and C. S. Reeve; "Calibration of Testing Machines," H. F. Moore; "Ideal and Practical Test Relations Between Elasticity and Plasticity, Tenacity and Brittleness," F. B. Seely.

## SUMMER RAINS FILL DIABLO DAM



*Wide World*

**Recent rains filled to overflowing the great Diablo Dam, a unit in Seattle's municipal hydro-electric development on the Skagit River, Wash., which will go into service soon with two 90,700-hp. turbines. These will be the largest capacity units of the Francis type so far installed in this country**

▼ ▼ ▼

## Power Company Sells Plant To City of Jamestown, N. Y.

SALE of the generating and distributing facilities of the Niagara, Lockport & Ontario Power Company in Jamestown, N. Y., and adjoining villages of Falconer, Celleron and part of Ellicott, to the City of Jamestown for $750,000 was approved on July 30 by the New York Public Service Commission. The sale is the result of negotiations started by Chairman Milo R. Maltbie, of the commission, who suggested that the company dispose of its plant to the city in order to eliminate duplication of service and competition in the city.

Under the new set up Jamestown will supply the surrounding villages with electricity at the same rates charged by the company. The city had filed previously with the commission a new schedule proposing a 10 per cent reduction in rates for the municipality. This was held up pending approval of the sale of the privately owned system.

## Beauharnois Inquiry Ends With Statement on Finances

THE INQUIRY into the affairs of the Beauharnois Power Corporation by a special committee of the Canadian House of Commons was concluded on July 22. Before the committee's report is presented to Parliament, a conference will be held with the Quebec Government, arising out of the fact that the company secured its power rights through a charter granted by the Legislature of that province. In the meantime, members of the Dominion Government have been giving serious consideration to the future of the company and its project for the development of a large part of the flow of the St. Lawrence River between Lakes St. Francis and St. Louis. The possibility that the government will assume a degree of control over the enterprise is by no means remote.

The last day of the inquiry was featured by an emphatic statement from Sir John Aird, president of the Canadian Bank of Commerce, that current revelations are jeopardizing the Beauharnois Corporation's prospect of completing its project. On the ground and in various material plants, the Beauharnois operations are furnishing employment for some 6,000 men. To continue them the company will have to float another bond issue at once; for at present it is living on temporary bank advances.

The cost of the Beauharnois project to date has been $29,768,816, according to A. F. King, committee auditor. In an exhaustive analysis of the balance

sheet of the company, Mr. King said it would be fair to assume that slightly over seven millions represented "water." When questioned later on this point, Mr. King admitted he had not taken into consideration any value that might be attached to the company's charter from Quebec or the approval of its plans by the Dominion.

## Large Attendance Expected At the Leipzig Trade Fair

THE HISTORIC Leipzig Trade Fair, comprising 7,500 exhibits from 24 countries, and attended by buyers from 72 countries, will be held from Aug. 30 to Sept. 3 this year. For nearly 700 years this German enterprise has regularly attracted merchants from all over the world. This year more than 185,000 buyers are expected to purchase their needs there.

All types of apparatus in every industrial field will be represented among the exhibits. The newest products of five continents will be attractively displayed in 60 special buildings conveniently grouped to facilitate inspection. American manufacturers will be represented by more than 200 exhibits.

Detailed information concerning every department of the fair may be obtained by addressing the Leipzig Trade Fair, Inc., 10 East 40th St., New York City.

## Allis-Chalmers Completes Purchase of Brown Boveri

THE ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, Wis., announces that it has completed acquisition of the principal assets of the American Brown Boveri Company, Camden, N. J., and the capital stock of the Condit Electrical Manufacturing Corporation, Boston, Mass.

After finishing the manufacture of goods on order at Camden, the large apparatus departments and work of American Brown Boveri, with substantially the same personnel, will be transferred to the Allis-Chalmers' plants at Milwaukee and Pittsburgh, it is stated, while the remainder will be moved to the Condit plant at Boston. Allis-Chalmers district and branch sales offices will in the future serve as the main outlets for the former American Brown Boveri products. The corporate entity of the Condit corporation will be retained as at present, and with few exceptions, the present sales connections of Condit throughout the United States will be continued.

By the purchase of these companies, Allis-Chalmers secures several new lines of equipment, including mercury arc rectifiers, blowers, electric furnaces, oil circuit breakers and electric railway apparatus.

## COMING CONVENTIONS

**American Society of Mechanical Engineers.** Regional meeting in Kansas City, Mo., Sept. 7-9. Annual meeting in New York City, Nov. 30-Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

**American Institute of Electrical Engineers.** District meeting at Lake Tahoe, Calif., Aug. 25-28. District meeting at Kansas City, Mo., Oct. 22-24. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

**American Welding Society.** Fall meeting at the Copley-Plaza Hotel, Boston, Mass., Sept. 21-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

**Association of Edison Illuminating Companies.** Forty-seventh annual meeting at The Greenbrier, White Sulphur Springs, W. Va., Sept. 21-25. Secretary, Preston S. Millar, 80th St. and East End Ave., New York City.

**International Railway Fuel Association.** Annual convention at the Hotel Sherman, Chicago, Ill., Sept. 15-16. Secretary, C. T. Winkless, Room 700, La Salle Street Station, Chicago, Ill.

**National Association of Power Engineers.** Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

**Southwest Power Conference and Show** will be held in Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, George F. Klein, Chamber of Commerce, Kansas City, Mo.

**Third International Conference on Bituminous Coal.** At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

**Universal Craftsmen Council of Engineers.** Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

## Combustion Engineering to Sell Carbonization Plant

WILFORD R. WOOD and the Irving Trust Company, receivers of the International Combustion Engineering Corporation, filed a petition on July 24 in the United States District Court, Southern District of New York, for an order approving the proposed sale to the Public Service Electric & Gas Company of New Jersey of the low-temperature carbonization plant near New Brunswick, N. J., at a total price of $75,165.44. Operation of the plant had been carried on in an effort to make it commercially successful and fulfill obligations to supply a certain amount of gas daily to the Public Service company, it is stated in the petition, but such operation has continually resulted in such heavy losses that it was decided to sell the plant. The Public Service company purchased on April 1 the water-gas plant operated in conjunction with the distillation plant.

# Personals

WILLIAM H. LARKIN, JR., for many years plant engineer of the United States Rubber Company at New Haven, Conn., and later division power and safety engineer and consulting steam engineer for the same company, will enter into general consulting practice in the New England district this fall, with offices in Boston, Mass.

WILLIAM H. SMITH, of Prattsville, Ala., has been appointed a member of the Muscle Shoals Commission by Governor B. M. MILLER of Alabama. Mr. Smith succeeds Professor L. N. DUNCAN, director of the United States Agricultural Service for Alabama, who resigned from the Muscle Shoals Commission when informed that it was contrary to the policy of the Service for one of its employees to serve on another state board.

J. D. Ross, recently reinstated as superintendent of the City Light Department of Seattle, Wash., has been named chairman of the Board of Public Works by Mayor ROBERT HARLIN. The Mayor and Mr. Ross are beginning a first hand study of the City's Skagit River development for purpose of working out details of an operating and construction program.

DR. PHILIP G. WRIGHT has been appointed by the Federal Power Commission as special statistician to assist the commission in the study it is making under the direction of Dr. Walter Splawn of the ownership, control and affiliations of public-utility operating companies which hold licenses under the Federal Water Power Act.

## Obituary

WATSON HAWLEY, for the past sixteen years president of W. Hawley & Company, Detroit, Mich., died in Toledo, Ohio, on July 12. Mr. Hawley was at one time sales manager of the McNaull Boiler Company, of Toledo. He enjoyed a wide acquaintance among those associated with the power field throughout the Middle West.

WILLIS EDWARD HALL, retired consulting engineer who was the first to advocate the electrification of steam railroads and to experiment with direct electric drive of machines, died on July 25 in Philadelphia, Pa. He was born in that city on July 20, 1860. After graduating from the University of Pennsylvania, he worked in the designing department of the Baldwin Locomotive Works, later going to the Pennsylvania Railroad shops in Altoona, where he introduced the first electrically driven traveling cranes. In 1902 he became a consulting engineer in New York, remaining until his retirement in 1912. Among his inventions was a device for automatically controlling the return in steam heating systems.

# Business Notes

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., through N. C. Symonds, commercial vice-president at the Chicago office, announces that Fred T. Whiting has been appointed northwest district manager of the company. In this position, Mr. Whiting will have charge of company activities in Illinois, Wisconsin, Minnesota, Iowa, Nebraska, Wyoming, North Dakota, South Dakota, and certain sections of Montana and Indiana.

CHICAGO PUMP COMPANY, Chicago, Ill., announces the appointment of the following representatives: W. G. Krueger will be manager of the Buffalo office, located at 91 Tremont St., Kenmore, Buffalo, N. Y.; Edwin J. Richard, 528 Chamber of Commerce Bldg., Cincinnati, Ohio, will represent the company in that territory; Drake Engineering Company, 915 Reibold Bldg., Dayton, Ohio, will cover the Dayton area; Oklahoma Heating Supply Company, 232 Commerce Exchange Bldg., is appointed for Oklahoma City, Okla., with R. I. Ludwig as sales manager; R. W. Lamkin, Pyramid Life Bldg., will operate the Little Rock, Ark., territory; and William C. Craig, 244 Kennedy Bldg., Tulsa, Okla., will handle the Tulsa territory.

NATURAL GAS EQUIPMENT, Inc., Los Angeles, Calif., announces the appointment of James C. McCluskey as sales manager of the southern division with headquarters in Los Angeles. Mr. McCluskey has been associated with the company for the past eight years in the California and Mid-Continent fields. In his new capacity he will have charge of sales in southern California, including the Ketleman Hills area.

PAUL B. HUYETTE, president of the PAUL B. HUYETTE COMPANY, of Philadelphia, Pa., for the past 30 years, was elected president of the Lehigh National Bank in the North Penn section of Philadelphia, at a recent meeting of the bank's board of directors. Mr. Huyette, who has been chairman of the finance board of the bank since its organization, succeeds the late Dr. M. F. Sullivan as president.

LINDE AIR PRODUCTS COMPANY, New York City, received the *Class & Industrial Marketing* cup award for the best exhibit of industrial advertising at the ninth annual convention of the National Industrial Advertisers Association, held recently in New York. The exhibit consisted of an advertising and publicity campaign for the promotion of oxy-acetylene welding in the heating and piping field, and included such features as technical handbooks on design and fabrication methods, the company-owned publication *Oxy-Acetylene Tips*, direct mail for jobber use and special advertising for individual products used in the process.

## How's Business?

STEEL PRODUCTION, turning upward slightly out of season, seems to be joining other industries responding to diversified consumer demand, according to *The Business Week*, Aug. 5. This stimulation from current consumer replacement needs is reflected also in the steady unseasonal upswing of electric power output. Even construction, the key to recovery, continues to resist further decline. The close fluctuations of commodity prices also lend some encouragement to those who believe that this summer's slackness will see the end of prolonged stagnation in the domestic scene and that slow improvement is scheduled to start in the Fall.

Production of electricity by public utilities for the week ended July 25 was 1,680,358,000 kw.-hr., according to N.E.L.A. figures. This shows an increase over the previous week, but it is 1.9 per cent below the corresponding period of last year.

# Trade Catalogs

SPEED REDUCERS—The complete line of Palmer-Bee speed reducers is described and illustrated in Catalog No. 53 just issued by the Palmer-Bee Company, Detroit, Mich. Full construction details and engineering specifications are given for herringbone, spur and worm-gear speed reducers.

THERMOMETERS—Moeller Instrument Company, 261-5 Sumpter St., Brooklyn, N. Y., has just issued a new catalog (No. 35) covering mercury-filled dial indicating thermometers, which are supplied in various ranges from —40 to + 1,000 deg. F., or equivalent.

LUBRICATION—A comprehensive description of the construction, operation and advantages of the "Ideal" system of lubrication, a constant and controlled system for applying grease to bearings, is given in an illustrated booklet recently published by the Ideal Lubricator Company, Packard Bldg., Philadelphia, Pa.

BELT DRIVES—"Texrope Drives for Heating and Ventilating Systems" is the title of new bulletin (No. 1247) of the Allis-Chalmers Manufacturing Company, Milwaukee, Wis. The booklet contains information on the construction and installation of these drives, together with many interesting illustrations of the public buildings they serve.

METALS AND PIPING—The Republic Steel Corporation, Republic Building, Youngstown, Ohio, has just issued three interesting publications, as follows: "Sheet Iron—A Primer" is a 64-page illustrated booklet telling in non-technical language the story of iron-working and describing, step by step, modern commercial practice of sheet rolling. "Toncan Iron Pipe for Permanence" is likewise a 64-page booklet showing many installations and applications of copper molybdenum iron alloy pipe, together with several typical examples of service under unusually severe conditions. "Agathon Alloys Steels" is an illustrated handbook of 132 pages giving recent and authoritative data on alloy steels, along with complete instructions, in convenient chart form, for heat treatment of these steels.

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# Fuel Prices

## FUEL OIL

**Boston**—July 27, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.85c. per gal.; 28@32 deg., 4.8c. per gal.

**New York**—July 30, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 3.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 4.75c. per gal.

**Philadelphia**—July 22, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

**Pittsburgh**—July 22, f.o.b. local refinery, fuel oil, 30@34 deg., 2.375c.@ 2.625c. per gal.; 36@40 deg., 2.375c.@ 2.625c. per gal.

**Cincinnati** — July 28, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

**Chicago**—July 28, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 22.5c. per bbl.; 22@24 deg., 25c. per bbl.; 24@26 deg., 27.5c. per bbl.; 26@28 deg., 32.5 per bbl.; 28@30 deg., 37.5 per bbl.

**St. Louis** — July 28, tank-car lots, f.o.b. St. Louis, 24@26 deg., 99.5c. per bbl., or 42 gal.; 26@28 deg., $1.045 per bbl.; 28@30 deg., $1.095 per bbl.; 30@32 deg., $1.145 per bbl.; 32@36 deg., gas oil, 2.401c. per gal.; 38@40 deg., distillate, 2.901c. per gal.

**Dallas**—July 25, f.o.b. local refinery 24@26 deg., 70c. per bbl. or 42 gallons.

## COAL

| Bituminous (Net Tons) | At Mine, for Shipment to | Price per Ton |
|---|---|---|
| Pool 9, super low-vol. | New York | $1.65 @$1.80 |
| Pool 10, h. gr. low-vol. | New York | 1.50 @ 1.65 |
| Pool 11, low-vol. | New York | 1.40 @ 1.50 |
| Smokeless, mine-run | Chicago | 1.50 @ 1.75 |
| Smokeless, slack | Chicago | .50 @ 1.10 |
| Harlan, Ky., slack | Chicago | .85 @ 1.10 |
| Franklin, Ill., mine-run | Chicago | 2.15 |
| Franklin, Ill., screen | Chicago | 1.10 @ 1.75 |
| Ind. 5th Vein, m.-r. | Chicago | 1.20 @ 1.75 |
| Standard Ill., mine-run | St. Louis | 1.25 @ 1.40 |
| W. Ky., mine-run | Louisville | .85 @ 1.00 |
| W. Ky., slack | Louisville | .50 @ .75 |
| Pittsburgh, mine-run | Pittsburgh | 1.35 @ 1.45 |
| Smokeless, mine-run | Cincinnati | 1.65 @ 1.75 |
| Smokeless, slack | Cincinnati | .75 @ 1.25 |
| Kanawha, mine-run | Cincinnati | 1.00 @ 1.25 |
| Kanawha, nut-slack | Cincinnati | .50 @ .85 |
| **Anthracite (Net Tons)** | **At Mine, for Shipment to** | **Price per Ton** |
| Buckwheat | New York | $3.15 @$3.25 |
| Barley | New York | .90 @ 1.40 |

# New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

**Ill., Mounds**—City will have surveys under way soon on municipal light and power plant and waterworks improvements to include distribution system, reservoir, pumping station, etc. Russell & Axon, 6200 Easton Ave., St. Louis, Mo., are engineers.

**Ind., Fairmount**—City plans a new waterworks system including pumps and equipment. Estimated cost $15,000.

**Ind., Schneider**—School Commissioners, H. P. Simms, will receive bids until Aug. 12 for the construction of a new heating plant and system for school building. Estimated cost $25,000. Private plans.

**Ia., Sioux City**—Swift & Co., Union Stock Yards, Chicago, Ill., awarded contract for a 2 story, 65 x 102 ft. refrigerator building to W. A. Klinger, Warnock Bldg., Sioux City. Estimated cost $85,000. Cooling system will be installed.

**Kan., Dodge City**—Kansas Power Co., c/o H. S. Kilby, Gen. Mgr., Salina, awarded contract for the construction of a 50 x 125 ft. power plant at Fort Dodge Rd. here, to L. E. Myers Co., 53 West Jackson Blvd., Chicago, Ill.

**Me., Charleston**—Higgins Classical Institute, E. Herrick, Pres., awarded contract for the construction of a boiler house and coal pocket to W. H. McPherson, 22 Hodsdon St., Bangor. Estimated cost $25,000.

**Mass., Braintree**—Town awarded contract for the construction of a pumping station to C. A. Batson, 26 Arlington St., Brockton. Estimated cost $15,000.

**Mass., Dorchester** (Boston P. O.)—Boston Ice Co., 11 Deerfield St., Boston, awarded contract for alterations to ice manufacturing plant at 200 Geneva Ave. here, to M. P. Standke, 67 Porthshine St., Brighton.

**Mass., Palmer** — Commonwealth of Massachusetts, Dept. of Mental Diseases, will soon receive bids for the construction of a heating plant at Monson State Hospital. Estimated cost $300,000. E. C. Brown Co., 77 Summer St., Boston, is engineer.

**Mass., Wrentham**—Commonwealth of Massachusetts, Dept. of Mental Diseases, will soon receive bids for the construction of a 3 story employees building and heating plant at State School. Estimated cost $150,000. J. H. Ritchie & Associates, 250 Stuart St., Boston, are architects.

**Mo., Joplin**—Joplin Stock Yards Inc., L. P. Buchanan, Pres., 116½ West 5th St., will build a stock yard group including stock pens, office, two trailer unloading docks, loading and conveying equipment, etc. Estimated cost $100,000. Work will be done by local labor.

**Mont., Helena**—U. S. Veterans Bureau, Washington, D. C., awarded contract for the construction of an infirmary building and boiler house at U. S. Veterans Hospital here to Murch Bros. Construction Co., Railway Exchange Bldg., St. Louis, Mo. $307,500.

**N. Y., Buffalo** — Adjutant General, State Capitol, Albany, will receive bids until Aug. 13 for replacement of boilers and repairs to heating system at 174th Infantry Armory here.

**N. Y., Eltingville** (sta. Staten Island)—New York & Richmond Gas Co., 691 Bay St., St. George, plans the construction of an illuminating gas plant at Sycamore St. and Richmond Ave. here. Estimated cost $40,000. Private plans.

**N. C., Oteen**—U. S. Veterans Bureau, c/o L. H. Tripp, Washington, D. C., will receive bids until Aug. 11 for a 76 x 84 ft. boiler house, including chimney, pumping equipment, etc., at U. S. Veterans Hospital here.

**Okla., Pryor**—City is having plans prepared for the construction of a municipal light plant. Estimated cost $40,000. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

**Tex., Dallas**—Neiman-Marcus Co., Main and Ervay Sts., awarded contract for the construction of complete air conditioning and cooling system to Smith & Whitney, Cedar Springs Ave. Estimated cost $30,000.

**Tex., Dallas**—Preston Road Fresh Water District, I. P. DeLoache, Chn. Bd. of Supervisors, will soon award contract for waterworks improvements, including pump house, pumping equipment, etc. Estimated cost $175,000. Koch & Fowler, 801 Central Bank Bldg., are engineers.

**Tex., Fort Sam Houston**—Constructing Quartermaster, will receive bids until Aug. 24 for construction and completion of engineering shop, connecting bays, dope house, dope storage building and boiler house at Duncan Field.

**Tex., Tyler**—Peoples National Bank, c/o S. R. Greer, Pres., had preliminary plans prepared for the construction of a 10 or 15 story bank and office building. Estimated cost $500,000. A. C. Finn, Bankers Mortgage Bldg., Houston, is architect.

**Vt., Northfield**—University of Norwich, C. A. Plumley, Pres., plans addition to heating plant. Estimated cost $50,000. Architect not selected.

**Ont., Preston**—Town plans to increase water supply including new wells, pumps, etc. Estimated cost $15,000. James, Proctor & Redfern, 36 Toronto St., Toronto, are engineers.

**Que., Montreal** — Canadian General Electric Co. Ltd., 941 Inspector St., awarded contract for a 69 x 154 ft. warehouse at Beaver Hall Hill to G. A. Fuller Ltd., Canada Cement Bldg. Estimated cost $425,000.

## Equipment Wanted

**Conduit, Conduit Fittings, Switches, etc. — Washington, D. C.**—A. L. Flint, General Purchasing Officer of Panama Canal, will receive bids until Aug. 7 for conduit, conduit fittings, panelboards, switches, etc.

**Conveying Equipment—Ottawa, Ont.**—Bd. of Control, Transportation Bldg., will receive bids until Aug. 11 for furnishing and installing pneumatic conveying equipment, etc., in connection with proposed alterations and additions to water purification plant and pumping station on Lemieux Island. Estimated total cost $1,300,000.

**Electric Motors, Blowers, etc. — Winston-Salem, N. C.**—D.-N. Corp., wants catalogues, price lists and samples from manufacturers for electric motors, blowers, fans, air preheaters, ash hoists, etc.

**Generating Units—Lake Mills, Ia.**—City, c/o J. C. Olson, Mayor, will receive bids until Aug. 17 for one 200 and one 280 hp. Diesel engine generating units complete with generating equipment for proposed 38 x 52 ft. power plant. $90,000.

**Engine, Pump, etc.—Cairo, Egypt**—Ministry of the Interior, will receive bids until Sept. 15 for one 16 hp. oil engine, centrifugal pump, capacity 15 litres a second, etc., for water supply at Guezirat-Chandamel.

**Engines—Cairo, Egypt**—Ministry of Public Works, will receive bids until Sept. 1 for four 150 bhp. Marine Diesel engines with gear accessories, etc., to be used for propelling coal barges.

**Pumping Equipment—Santa Cruz, Calif.**—City plans installing pumping equipment in municipal water plant.

**Pumping Equipment—Paterson, N. J.**—Passaic Valley Water Commission, J. Wilson, Pres., 156 Ellison St., will receive bids until Aug. 10 for furnishing and installing two 6 m.g.p.d. motor driven centrifugal pumping units for proposed Great Notch pumping station, Great Notch.

**Transformers—Wellington, N. Z.**—Post & Telegraph Dept., will receive bids until Sept. 3 for 25 telegraph transformers, etc.

**Transformers — Wellington, N. Z.** — Public Works Supply & Tenders Committee, will receive bids until Oct. 20 for two 3 ph. boosting transformers complete with accessories for Arapuni plant.

## Industrial Projects

**Calif., Long Beach**—Fields Chemical Corp., 1202 Financial Center Bldg., Los Angeles, had plans prepared for a metallurgical coke plant, initial capacity 20 ton daily, here.

**Calif., Los Angeles**—Curtis Mfg. Co. Inc., 405 Lane Mortgage Co. Bldg., had plans prepared for 1 and 2 story, 200 x 575 and 100 x 100 ft. factory and office at San Fernando Rd. and Brazil St. Estimated cost $200,000. V. W. Houghton, 617 North New Hampshire St., is architect. C. A. Sanborn & Co. Ltd., 910 Black Bldg., are consulting, mechanical and electrical engineers. E. J. Walsh, 515 Orange Grove Ave., Alhambra, is structural engineer.

**Conn., Ansonia**—American Brass Co., Grand and Meadow Sts., Waterbury, will build addition to plant on Canal St. here. Estimated cost $40,000. Private plans. Work will be done by day labor.

**Ill., Chicago**—Clearing Industrial District, 38 South Dearborn St., Owners and Contractors, will build a 2 story factory to include offices, laboratories, etc., at 6901-23 West 65th St. Estimated cost $500,000. Pepsodent Co., 919 North Michigan Ave., Chicago, tooth paste and antiseptic manufacturers, is lessee.

**Ind., Evansville** — Sunbeam Electric Co., awarded contract for the construction of a factory at West Morgan St., to M. J. Moffman Construction Co., 1011 Central Union Bldg. Estimated cost $40,000.

**Mass., Canton**—Plymouth Rubber Co. Inc., Revere St., is receiving bids for a 2 story unit to factory. Estimated cost $40,000. J. R. Worcester Co., 79 Milk St., Boston, is engineer.

**Miss., Jackson**—Dixie Glass Bottle Mfg. Co., awarded contract for the construction of a glass plant to T. B. Scott, Jackson.

**Pa., Indiana**—Diamond Glassware Co., H. W. Thomas, Mgr., plans to rebuild glass plant destroyed by fire. Private plans.

**Tex., Corpus Christi**—Southern Alkali Corp., subsidiary of Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa., and American Cyanamid Co., 535 5th Ave., New York, N. Y., plans the construction of a plant for the manufacture of soda ash, caustic soda and other products from raw materials here, also ship channel from Corpus Christi to plant site. Estimated cost approximately $10,000,000. Private plans.

**Tex., Longview**—Bell Refining Co., Tulsa, Okla., awarded contract for the construction of a 10,000 bbl. refinery near here to Gregg Construction Co., Longview, Tex. Estimated cost $90,000.

**Tex., Refugio**—G. P. Shelton, et al., Tulsa, Okla., plans the construction of a gasoline refinery, 10,000,000 cu.ft. daily capacity here. Estimated cost $150,000. Private plans.

**Que., Montreal** — McKesson & Robbins Inc., W. N. Van Fant, Pres., Grasmere Ave., Fairfield, Conn., plans the construction of a branch plant here. Initial cost $1,000,000.

**Que., Montreal**—Rootes Ltd., London, England, manufacturers of Hillman and Humber cars and Conaner trucks, plans the construction of a plant here. Initial cost $250,000.